TQM Volume-12

Total Quality Management in Factory Management

Matrix data analysis

2025a Edition

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Factory Management Institute

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At the time of publication and over the age of 80, he continues to work on disseminating original Japanese methods and imparting more knowledge, even that learned from the pioneers. He has been an international consultant for the past 30 years, working in over 11 countries, where he has trained clients as both a lecturer and a writer. Even now, he is experimenting, researching innovative methods, and growing in the field of Production Management and Corporate structuration.

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Título de la Versión Española:
Factory Management – TQM Total Quality Management. Volumen 12 -2025a
TQM-12, Análisis de Datos en Matrix.

Title of English Version:
Factory Management - TQM Total Quality Management. Volume 12 -2025a
TQM-12, Matrix data analysis

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Traducción, Edición y Adaptación de la versión española:
Edition and Adaptation of the English version:
Sensei Eduardo L. García – The Netherlands © 2025
https://es.linkedin.com/in/edulgg

El Documento ha sido editado para su impresión en Doble Cara sobre DIN-A4 + Encuadernación
This document has been edited to Double-Side Printing over DIN-A4 + Bookbinding

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TQM-12 Video Summary in English. LinkedIn publication by the Factory Management Institute

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Icons:

Notes: Going back to the central theme.

The third level of the Issue provides more clearness to the structure of the text to the more relevant.

Lower levels of the Issue, commonly 6th or 7th, and, pointing out necessary explanations about pictures or graphs.

UPDATING TABLE:

Date, Version-Previous & V-Next	Chapter (I..XX...)	Chapter Point.- sub-point : (Updating)

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SUMMARY [eng]

*The document "TQM Volume 12: Factory Management - Matrix Data Analysis" by Kouichi Kimura discusses the **Matrix Data Analysis** method, one of the New 7 Tools of Quality Control. This method is data-driven and parameterizes factors such as Man, Machine, Material, Method, Measure, Money, and Environment (5M1E) to understand relationships and propose solutions. However, Kimura Sensei questions its usefulness for simple quality improvements, suggesting that scatter plots or cross-charts are often sufficient.*

*A consulting case is described where a company faced **bankruptcy due to insolvency and cash flow shortages**, exacerbated by **excess inventory**. The factory was unable to adapt to "high-mix, low-volume" production and constant design changes while maintaining a batch production system. The proposed solution is the introduction of the **Toyota Production System (TPS) and Just-In-Time (JIT),** focusing on one-to-one production to minimize inventory.*

*The document also criticizes the **overreliance on advanced statistical tools** without a true understanding of the process ("torturing the data"), as illustrated by a failed Six Sigma project that failed to identify the root cause of a variability problem. Instead, it promotes the use of **intuition and the creative ability of the human brain** (DMN, Idling Brain) and basic quality control tools for effective problem-solving.*

TQM-12 summary - 2min. generated by Google NotebookLM

RESUMEN [esp]

El documento "TQM Volumen-12: Gestión de Fábrica - Análisis de Datos en Matriz" de Kimura Sensei aborda el método de **Análisis de Datos en Matriz**, una de las Nuevas 7 Herramientas de Control de Calidad. Este método se basa en datos y parametriza factores como Hombre, Máquina, Material, Método, Medida, Dinero y Entorno (5M1E) para comprender relaciones y proponer soluciones. Sin embargo, Kimura Sensei cuestiona su utilidad para mejoras de calidad simples, sugiriendo que diagramas de dispersión o gráficos cruzados son a menudo suficientes.

Se relata un caso de consultoría donde una empresa enfrenta **bancarrota por insolvencia y escasez de flujo de caja**, agravada por un **exceso de inventario**. La fábrica no lograba adaptarse a una producción de "alta mezcla y bajo volumen" y constantes cambios de diseño, manteniendo un sistema de producción por lotes. La solución propuesta es la introducción del **Sistema de Producción Toyota (TPS) y Just-In-Time (JIT)**, enfocándose en la producción uno a uno para minimizar el inventario.

El documento también **critica la dependencia excesiva en herramientas estadísticas avanzadas** sin una verdadera comprensión del proceso ("torturar los datos"), como se ilustra en un proyecto Six Sigma fallido que no identificó la causa raíz de un problema de variabilidad. En su lugar, promueve el uso de la **intuición y la capacidad creativa del cerebro humano** (DMN, Idling Brain) y herramientas básicas de control de calidad para la resolución efectiva de problemas.

TQM-12 Resumen en Audio - 20min generado por Google NotebookLM

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I. Prologue

This is the final one of the New QC 7 Tools. It is indeed a troublesome theme to write this method. I feel really weighed down. But I need to write to finish the comment on the New QC 7 Tools.

There are three reasons: the first reason is that you cannot use it for quality improvement. This method is completely data-driven. I never say that QC doesn't need concrete data, but... The second reason is gathering reliable data. It is the second difficulty for you. The third reason is the difficulty of using the matrix; despite its creation being a considerable effort, it is still challenging to comprehend the matrix data.

Is QC so difficult? No, it is not. If the multivariate is only 4, it is not necessary to use such a troublesome method. This method is targeted to analyze many of multivariate numbers—for instance, the analysis for market research and new product development.

After all, Matrix Data Analysis is the act of analyzing something using Matrix Data.

For it, it is necessary to parameterize 5M 1E (Man, Machine, Material, Method, Measure; KPIs & Money; Investment and Environment).

Parameterize. How do you parameterize, for instance, Man (Worker)? Workers' age, years of employment, skill evaluation, working hours/day, etc. And, (Working) Environment: Lighting, Noise, Odour, Temperature, Air conditioning, Break room & cafeteria, Beautification, etc. The parameters can extend without limits.

Then, data gathering can begin after deciding on parameters. Fortunately, in the near future, AI can help with the analysis to find an optimized answer. But making and teaching data will remain.

But… is QC so complicated? Even so, the most important thing is how to identify the necessary elements in 5M1E. Yes, it is the field of ideas.

To analyze something by using Matrix Data, and the leading actor of this method is Matrix Data, which is only one kind of table. And, is this a QC tool? …It is possible to replace the Fish-Bone Diagram with a KJ. And as you will find later, it is possible to replace the Scatter plot graph as well.

So please read this column with the above in mind.

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II. Matrix Data Analysis

Let's talk about Matrix Data Analysis… Strangely enough, this method is one of the New QC 7 Tools. It is a tool of QC (Quality control).

Why is it strange? I will tell you later. But, firstly, let me introduce you to a positive point. This method is a good and valuable tool. My first experience of this method was more than 20 years ago.

After retiring from my previous company, I started the consultancy with my partner, who was a professional in Accounting (A). One day, we were invited by a middle-class manufacturing company. Then, we had a presentation about the Cost improvement activity of the departments. And there was a presentation by the design engineering department regarding a VA/VE activity.

I have to say that, when we were receiving the engineering presentation, there was a little incident. Actually, this company had difficulty meeting the cost-down requirement by the customer. Yes, "cost down" and not a "cost Kaizen".

The presentation was their activity of VA/VE activity of automotive parts, which were their main products and were gears and bearings.

When he was almost finishing the presentation, a little incident happened. A salesperson was coming into the meeting room and whispered to his boss (Sales department manager). Then, the Sales Manager (SM), Mr. President (P), the Engineering staff (Eg) and we just got some information regarding the order receiving of this product. The customer has decided to place an order with our competitor.

Then the President asked the group: —What and why did it happen? Just now we were receiving the presentation of the successful VA/VE example. These gear and bearing products are our main products.

The Sales Manager answered: —I'll try to get the customer's person in charge. Then he left the meeting.

Then the Accounting consultant asked the President: —What had happened?

—I also cannot understand so far —the President mentioned—. Anyway, it may be a fact that we are beginning to lose our main products that receive orders. Mumm… —he muttered— Anyway, we need to make an urgent countermeasure.

Then the president asked the Engineering staff: —Don't you know something of background, do you?

Showing a pale expression on his face, the Engineering staff hesitated: —Maybe... The cause may be the delay in response to the customer.

And he continued: —As you know, we submitted to the customer the new price using the material for which we just made a presentation. And… And our suggested price was accepted by the person in charge. But we had one claim from him. He required us to submit the rationale behind the choice of this material. Of course, we submitted the

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material test results and prototype examination results, which met the customer's specifications. Even so, he requested us to explain why the material was chosen. Then, we promised to submit the evaluation tests of all materials.

The assumptions from the Engineering staff continued for a while when the President asked: And? Have you done that?

The Engineering staff answered negatively: —No… ehmm… not yet.

—Did you have any difficulty submitting it? —asked the president.

—Actually, there are two difficulties. One reason is that it is necessary to summarize all data in one paper. The customer requirement was, as you know, very rash. And our times were spent on evaluating materials and prototypes, conducting tests, and conducting in-house acceptance tests. Then, urgently, we visited and submitted our suggestion to the person in charge. But an additional request was made by him…

—Another is the disclosure of cost. One of the evaluation items is the material price of suppliers. We don't want to disclose it.

In the meantime, the justification was carried out by the engineering staff. The Sales Manager then entered the meeting room and whispered to the president. Then the Sales Manager requests the Engineering staff: —Please make up the material in a hurry. And we will visit him tomorrow morning. He agreed to give us one chance to meet.

—Mumm… the Engineering staff muttered—… We need to say that it is impossible to make up this paper in one night. Also, how can we discuss the disclosure of material prices?

…

This was the background of teaching Matrix Data Analysis by Diagram. And now, the following was my suggestion.

How can they explain to the customer? —I asked myself—. The themes were two. One is to review the engineering data. Another is how to explain it to the customer, including the suppliers' prices. This was an engineering matter and my territory, and I suggested, with a smile, as next.

—Please —I requested—, let me know what materials you picked up? Because you are a professional in plastic gears and bearings. Rather than me, you have much knowledge.

The Engineering staff mentioned then: —We suggested one material by test and prototype. But this suggestion was rejected as a result. Of course, this prototype cleared the necessary specifications of the customer. But it was denied. The customer told us the basis for choosing this material. Why did we judge it to be the best?

—I see and... And what kind of materials did you consider in your VA/VE activity? —and before receiving any answer, I continued—: Once again, I would confirm with you: Cost Reduction requirement by customer. The target items were gears and bearings of automotive parts.

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—Your suggestion was rejected because of an unknown process of material selection. Correct? —I asked him finally.

—Uh... yeah… right.... And we considered the following materials: MC nylon, polyacetal, polycarbonate and three other kinds. And the test items were Mechanical properties, Wear resistance, Heat resistance, Chemical resistance, four different items and suppliers' material prices. In total, 17 evaluation items.

—It is good, I believe. Then, you finally choose this material and suggest it.

—So, what is your wish for me? After your reliable test of materials' test pieces and prototypes, you chose this material, MC nylon. But you couldn't get the customer's good understanding. Then, your wish is "How to get the customer's understanding". Is that right? —and without waiting for an answer, I continued—. Also, you wish to reconfirm this decision. You showed the test results of this material and the cost improvement effect…

—Cost reduction? Or cost improvement? But anyway, the customer wished to know how you chose it, right?

—Yes, it is —The Engineering staff admitted—. But it is not easy. Because there are so many data in papers. Therefore, we intend to explain how we chose the materials. But once again, the data materials are so many.

—Can I see the papers?

Then, they showed me the test results, and I asked them: —It seems to be very reliable data. And then, based on these data, you suggested the gear with MC nylon. So, probably, it is easy for you. Please make a Matrix Data Analysis by Diagram to review your suggestion and gain a good understanding of the customer.

—Matrix Data Analysis by Diagram? —The Engineering staff asked me.

—Yes, it is. It is easy. Just because you have finished the most challenging process of this method, which is the data gathering. Test items are probably sufficient. The longest time taken is the process of data gathering. It is already finished (seems to be).

Then I drew the following picture on the whiteboard. If you like, let's look at one example: —You have the data of your test here, have you? —I asked them.

Matrix Data Analysis by Diagram Form

—Firstly, please write the names of materials in the vertical axis column. Next, let's write the evaluation items in the horizontal axis column. See the following picture. It shows 10 items in the pulse Evaluation. But actually, 17 evaluation items. Below are just 10 items —I said even though I omit others in this exposition.

—Necessary materials evaluation items are Tensile Strength, Compressive Strength, etc. and the Unit price of the material. And finally, the column of your Evaluation…

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	Strength			Resistance		Chemical		Process ability		Cost	Evaluation
	Tensile	Compress	Bending	Abrasion	Heat	Oil	Solvents	Ease of	Characteristic	Unit price	
Material								processing	during molding	of material	
MC nylon,											
Company A											
Company B											
Polyacetal											
Company B											
Company C											
Company D											
Polycarbonate											
Company A											
Company B											
Company K											

—So, let's fill in each table cell.

—Wow, this is tough! —The Engineering Staff replied, followed by a conversation between some engineers.

—It is necessary to re-read the test materials. Mumm.. —mutterred one of them—. How did we choose MC nylon? Once again, review these in a hurry. But we need to respond to it tomorrow.

—However,... —hesitated one Engineering staff— We can do it, right?

—Anyway, our customer's requirement is so rushed. The test has taken too long before, but having it done by tonight... Well, there's no point in complaining. Let's split the work and check the documents.

—Mumm.. —muttered another Engineering staff—. But… It's absolutely impossible!

Then I asked them: —You have a difficulty with the delivery date of the answer, have you? —and after his general assent, I continued—. I see. Let me ask a question, please. Do you remember the test results?

—Yes and no —The engineering staff answered securely—. We remember it as the result. But we don't remember the numbers all exactly.

—I see —I admitted—. Once again. Do you have confidence in reviewing by the delivery date?

—Mumm.. The engineering staff muttered—… No, we have not. We are in serious trouble right now. We have reliable data. But the customer wants our detailed explanation. Then, we need to re-read the data. But so much data. It is physically impossible. The Matrix Data Analysis diagram is an example to explain. But it is also required of us to reread data.

Then I understand the grave situation: —It is indeed a troubling issue. Everyone —I requested—, my advice. Let you use your "intuition".

—Intuition!? —the engineering staff surprised—. Probably, such an unscientific approach cannot be accepted by the customer.

—Unscientific? —I exclaimed—. No, no, no. A decision by intuition is never unscientific if you have reliable experience. Additionally, it is not necessary to disclose

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this information. You can say to your customer that it is easier to see and understand. You just don't have to say it. Unscientific?

And I dive deeper into my empirical reasoning—No, not at all. Decision by Intuition is never unscientific. I will tell you later. And anyway, you need to start.

—OK, Mr. Kimura —the engineering staff admitted and requested me—: How to do it?

—When filling in the Matrix Data Analysis Diagram, there are 2 ways —I explained—. One is to write the actual numbers of the test. It is difficult for you, and making a decision is too complicated due to the complex table of numbers. Another is to use the 1-3-5 method of evaluation. Now I suggest you use the 1,3,5 evaluation method.

—Since we have the numbers, why not enter the actual figures? —the engineering staff detailed then—. The reasons are:

- Complex data matrix and column of cost (material price).
- There is the table cell of Cost. It is not good to disclose it. Our customer wishes to know how reliable our suggestion is. So, let's use the 1,3,5 evaluation method based on our intuition.

I suggested then: —OK. Please use the 1,3,5 evaluation method. Please use the following index: Evaluation of test results. (5) Excellent, (3) Nominal, (1) Bad. 2 and 4 are used. Evaluation Cost. (5) Cheap, (3) Average, (1) Expensive. And 2 and 4 are also unused. Please prepare cards of 1~5 written for each member. And —I remarked—: 3 Rules:

- Sufficient experience.
- Snap judgment and no deep thinking. Just use your intuition.
- If there is a big difference in opinion in the cards, listen to each opinion or check the actual data. Judgement by all. If there is a big difference in opinion, discuss or re-read the actual data.

—OK. Please start one by one —And the following table was made up. Indeed, it is a fictional Matrix Data Analysis by Diagram. It is only presented as an example:

	Strength			Resistance		Chemical		Process ability		Cost	Evaluation
	Tensile	Compressive	Bending	Abrasion	Heat	Oil	Solvents	Ease of	Characteristic	Unit price	
Material								processing	during molding	of material	
MC nylon,											
Company A	3	5	5	4	4	4	5	4	4	1	**40**
Company B	3	5	4	4	3	4	5	3	3	2	36
Polyacetal											
Company B	4	5	3	4	3	2	5	4	2	2	34
Company C	3	3	3	4	3	2	3	3	2	3	29
Company D	2	4	5	5	2	3	5	2	3	3	34
Polycarbonate											
Company A	5	5	2	5	3	3	5	3	4	2	37
Company B	5	5	2	5	2	3	4	2	3	3	34
Company K	3	5	2	5	2	3	5	3	3	5	36

Well, is the above example similar to a Matrix Diagram? Well… Not and Yes?!

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This example illustrates the correlation between gear materials and the corresponding characteristics, presented in numerical form. The purpose is to determine the best gear material based on numbers. Therefore, it is the analysis. But. But this uses symbolic numbers, such 1-3-5 evaluation, rather than actual numbers. The reason is to help the customer gain a good understanding. Then, it is possible to refer to it as a type of Matrix Data Analysis Diagram.

So, how is Matrix Data Analysis by Diagram different from Matrix Diagram? …I shall explain simply with the following table. Anyway, a significant difference between Matrix Diagram and Matrix Data Analysis is the use of numerical data. I show the difference in the following table.

Matrix Diagram vs Matrix Data Analysis Diagram Comparison Table

Item	Matrix Diagram	Matrix Data Analysis by Diagram
Purpose	Tools for visually displaying and analysing relationships between data sets.	Visualise multivariate data and analyse patterns and trends.Methods for analysing **numerical data** and summarising their characteristics.
Fields of use	Quality management, project management, causal analysis and resource allocation and problem solving.	Statistical analysis, quality control, machine learning, bioinformatics, **to analyse product characteristics, conduct market research and determine the characteristics of new products.**
Figure shape	Usually a row × column cross table (simple)	**Various** e.g. Heat maps, Scatter plots, Principal component plots
Data type	Mainly relationships between categories (Yes/No, strength/weakness) various data sets (e.g. concepts, tasks, status).	**Numerical data** (continuous variables, multidimensional data)and organizes evaluation items.
Visual element	Colour coding and symbols can be used to emphasize relationships.	Often visualized **using scatter plots and principal component analysis** based on numerical data.
Analysis functions	Intuitive relationship organization and inter-team coordination	**Quantitative pattern detection and statistical processing**
Depth of analysis	It shows relationships between data but does not necessarily include numerical details.	**Conduct a detailed analysis of numerical data to identify characteristics and trends.**
Scope (of a document)	Used in a wide range of fields, particularly useful in project management and quality control.	Often used primarily for **principal component analysis and product development** specifically.
Examples	Charts charting the correspondence between products and functions	PCA plots to detect abnormal products, correlation heat maps to discover factors
Tools	Excel, PowerPoint, handwriting, etc.	Python (pandas, matplotlib, scikit-learn), R, MATLAB, etc.

By Felo Search & Genspark & ChatGPT

Is this a tool of TQM?

When examining the characteristics of Matrix Data Analysis by Diagram, it becomes clear that this tool is primarily used for Product development and marketing. Of course, it is possible to use it for quality improvement. However, when used for quality improvement, it is typically employed as a tool for correlation analysis, accompanied by a Scatter plot diagram for visualization.

Scatter diagram: used to visualize the relationship between two variables and helps to analyze correlations.

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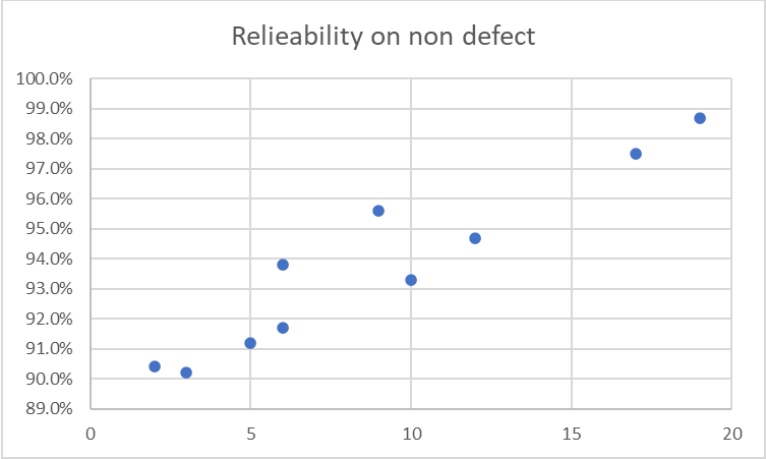
As an example, let me introduce a table. In the following example, the QA department of a company investigated the correlation between the Year of service and the Rate of non-defective products. The following two-dimensional matrix data were obtained:

Employee name	Years of service	Relieability on non defect
A	10	93.3%
B	17	97.5%
C	3	90.2%
D	6	91.7%
E	12	94.7%
F	5	91.2%
G	6	93.8%
H	19	98.7%
I	2	90.4%
J	9	95.6%

To visualize and analyze the correlation, a scatter plot diagram was created.



When looking at this scatter plot graph, it seems to be possible to say that “as Years of service increase, so does the Rate of non-defective products”. In other words, it can be considered that there is no major obstacle in combining Years of service and Rate of non-defective product as ‘one data’.

Here, it has drawn a straight line that takes into account both ‘length of service’ and ‘good quality rate’ at the position where the total distance between each plot on the scatter plot graph is the smallest (i.e. the position where the difference from the original data is the smallest).

This straight line becomes the new data with two dimensions reduced to one.

The basic idea of the matrix data analysis method is to reduce the number of dimensions of the data and make them easier to process by transforming multiple data that are correlated to some extent into ‘new data’ that has all the elements together.

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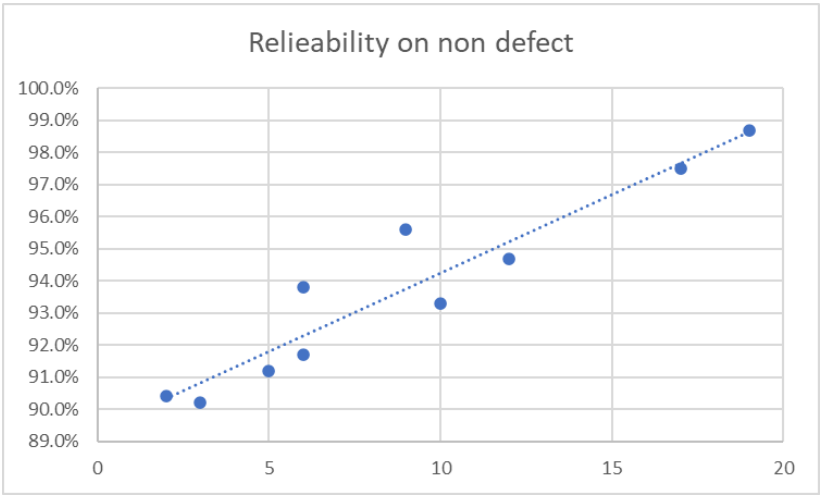


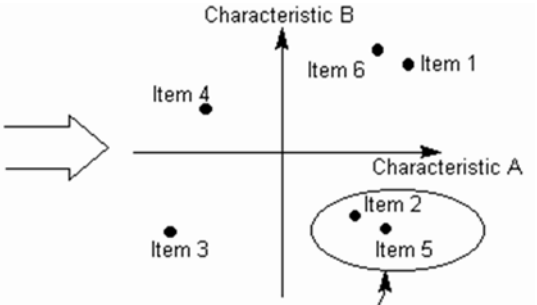
Scatter plot diagram

Please look at the above example. When looking at the Matrix Data Analysis by Diagram for quality improvement issues, a Scatter plot diagram is often used for visualization and correlation analysis.

Use of a scatter plot diagram? Yes, the meaning of "analysis" is to understand the relation of the data gathered. For this, a scatter plot diagram is used.

Another excellent example, in this case from SNS: Matrix Data Analysis Chart. This makes it easier to see how the individual items relate both to the characteristics and to one another, thus:

Measured Item	Character-istic A	Character-istic B
Item 1	10	8
Item 2	5	-4
Item 3	-8	-5
Item 4	-5	3
Item 5	7	-5
Item 6	8	9



What am I telling you? …I'm telling you that for quality improvement, we don't need such Matrix Data Analysis by Diagram. Of course, a correlation analysis is necessary for quality improvement activity. However, it is sufficient to use the Scatter (plot) diagram, which is one of the QC 7 Tools. But none of the New QC 7 Tools. Quite often, I use the following graph for quality control.

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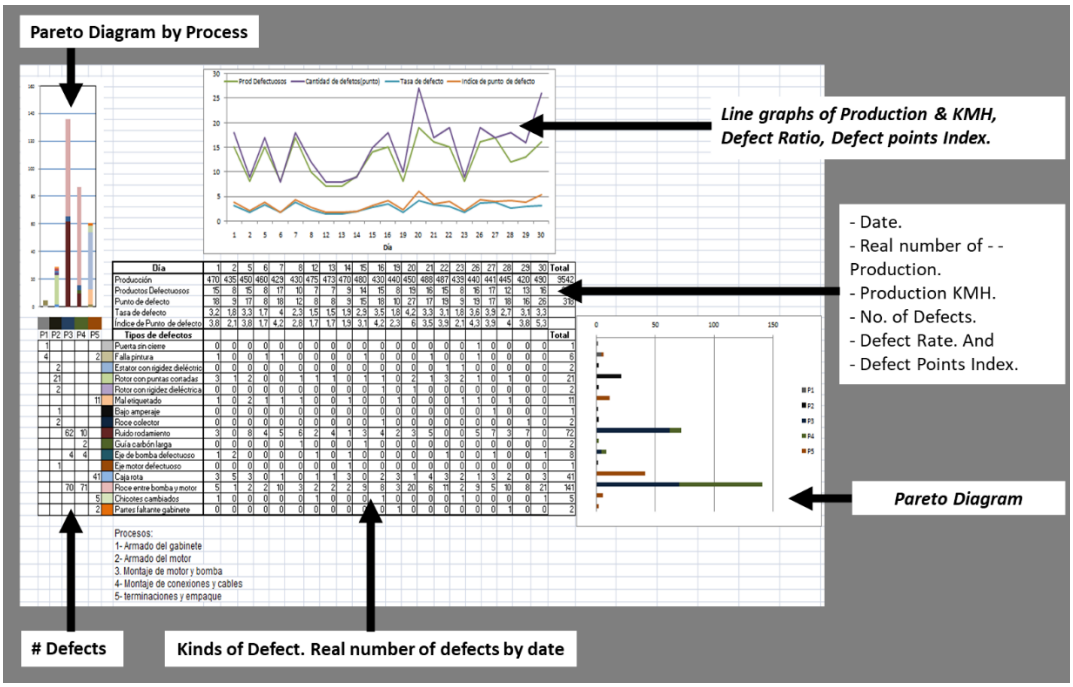
Cross Graph


Pareto Diagram by Process
Line graphs of Production & KMH, Defect Ratio, Defect points Index.
- Date.
- Real number of - - Production.
- Production KMH.
- No. of Defects.
- Defect Rate. And
- Defect Points Index.
Pareto Diagram
Defects
Kinds of Defect. Real number of defects by date

This graph displays three pieces of information using detailed data. The three pieces of information are (daily) Defect rate, Defect occurrence by Pareto, and Defect occurrence by process. The parameters are 3: Name of defect, Process and Date.

> Just a side note: When I taught this graph to an Indian company, a line manager used it for different information. He replaced the item "Process defect occurred" with "Person defect made". Yes, “process” to “person”. He replaced the focus. However, I required him to stop because of the bad morals in his proposal. Anyway, this "Cross graph" can be used for the analysis of any 2-dimensional issues.

It is also possible to argue that Matrix Data Analysis for quality improvement is not necessary. And I recommend that you use this Cross graph in your production line.

Matrix Data Analysis by Diagram for QC.

I saw two and three examples of the Matrix Data Analysis method in use. This was the purpose of quality improvement. But I omit to write these. Why?

It was so ridiculous. I can understand the efforts of the engineers who created these matrix diagrams. But when looking at the suggestion drawn by the Matrix data Analysis Diagram, I smiled bitterly. Because.

The suggestions were just the words of "Operator training and education, Introduction of Poka-Yoke, etc. With so many efforts!? Such solutions!? Ridiculous. So, a poor idea. So poor creative thinking.

Let's stop and no more comment about this New QC 7 Tool.

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Finaly…

What is Matrix Data Analysis?

Matrix Data Analysis is a method for visually understanding and analyzing data relationships. The technique is widely used, particularly in areas such as quality control and market research.

Overview of Matrix Data Analysis

***Definition**: Matrix Data Analysis is a technique for analyzing the relationships between different factors by organizing numerical data in a matrix format with rows and columns. This allows correlations and trends in the data to be more clearly understood.*

***Purpose:** The primary purpose of this method is to organize several assessment items together, identify problems and propose solutions through data visualization. It is beneficial for analyzing product characteristics and market needs.*

***Procedure**:*

1. *Factor selection: determine the two factors to be analyzed.*
2. *Data collection: Collect numerical data relating to each factor.*
3. *Creating a matrix: organize the collected data into a matrix.*
4. *Data entry: enter numerical data into the matrix.*
5. *Analysis and evaluation: Analyze the data using the matrix and evaluate the results.*

***Application examples**:*

1. *Product development: to determine the characteristics of new products, existing product characteristics can be analyzed and summarized in a matrix to derive the correct attributes for the target market.*
2. *Quality improvement: to identify the causes of customer complaints, relevant data can be organized in a matrix to analyze the root causes of problems.*

Matrix Data Analysis is a powerful tool for organizing and visually understanding data, especially when dealing with complex data sets.

(*By a textbook*)

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III. Jishu-Ken V group exercise: Cost Control[1]

TQM-11 JISHU-KEN IV Cost Control working group

Let's continue the dialogue of this ***Jishu-ken***. The issue discussed was bankruptcy due to insolvency and Cash Flow Shortages.

This company is going bankrupt. No, this representation wasn't suitable. Actually, he had already gone bankrupt in effect. However, he had been keeping alive through a strategy devised by Headquarters.

—Last week I visited the office of Kimura Sensei and had a dialogue regarding the DOPE storm —the **Hr** mentioned, and the following is the content of such a dialogue with him:

—Did DOPE members come to see you? —the **Hr** asked me.

—Yes —I agreed—, they did and asked me: "Do you think this plant has the capacity to pay you for the contract fee?". And I answered I don't know but please judge if it is necessary to continue the contract. Please tell me without hesitation.

—How do you think the DOPE's methodology of reform? —the **Hr** asked me again.

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[1] **Cost reduction/control** is a series of lectures about the interpretation of different costs regarding calculating the Profit and Loss statement adequately, depending on the activity and policy of the company:

JISHU-KEN IV – Cost Reduction – 11: [eng] https://archive.org/details/tqm-11-process-decision-program-chart/page/n49/mode/2up
JISHU-KEN III – Cost Reduction – 10: [eng] https://archive.org/details/tqm-10-the-matrix-diagram-and-qcc-working
JISHU-KEN II – Cost Reduction – 9: [eng] https://archive.org/details/tqm-9-pfmea/page/n35/mode/2up
JISHU-KEN I – Cost Reduction – 8: [eng] https://archive.org/details/tqm-8-the-arrow-diagram/page/n37/mode/2up Example of ***Jishu-Ken*** sessions of a middle managers working group: The group was studying the break-even point of the operations to reach profits in the short and medium term.
Cost Reduction – 7: [eng] https://archive.org/details/tqm-5-the-kj-method/page/n47/mode/2up
Cost Reduction – 6: [eng] https://archive.org/details/tqm-3-hardware-software-diagnose-cost-reduction-6
Cost Reduction – 5: [eng] https://archive.org/details/tqm-2-introduction-2-cost-reduction-5
Cost Reduction – 4: [eng] https://archive.org/details/tpm-16-oil-control-5/page/8/mode/2up
Cost Reduction – 3: [eng] https://archive.org/details/tpm-15-cost-reduction-3-and-consultancy-job-contnuation
Cost Reduction – 2: [eng] https://archive.org/details/tpm-14-clasification-of-cost-and-oiling
Cost Reduction – 1: [eng] https://archive.org/details/tpm-13-oil-control-3/mode/2up

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—Ha, ha, ha. I shouldn't have my comment. But as little as a general conversation. I have some experience in helping with reforms. And I felt that some cases were a "FakForm".

—"FakForm"? What is this?

—Sorry. This is my coined expression. "FakForm": is the meaning of Fake Reform. Gradually, I could understand the activity of DOPE, and my understanding is that this is probably the company-wide Cost Reduction (Cost Cut).

—Listen, Mr. **Hr**. If you intend to carry out a reform, it is essential to have a particular agenda or assignment.

—Agenda? —the **Hr** asked me, and the conversation dived deep just a little more; however, I prefer not to describe it just because it has no value added to the lesson.

The **Em** mentioned, now, into the 5th ***Jishu-ken*** Session: —Anyway, we will see it on another opportunity. Let's go back to our main "agenda", which is the Balance Sheet. Mr. **Af**. Thanks for joining our Jishu-Ken today.

—Oh no, not at all. Thank you so much for having me. And the theme of today is Balance Sheet, right?

—That's right —the **Em** confirmed—. Now we are on the brink of Bankruptcy. And we need to verify it with the data. Then, we wish to relearn the Balance Sheet using our actual data.

—It is a good thing —the **Af** agreed—. However, a little. The recognition of "On the brink of bankruptcy" is wrong, I think. Because our Balance Sheet tells us that our company has been in bankruptcy and not "on the brink", but already. We were thinking that our parent company are helping anytime and, in the future,…

—But our parent company declared to stop the money supply to help with our cash flow shortages…

—And as you know, our Managing Director went to the headquarters to negotiate to continue the help with cash flow. It was successful. But instead of this, DOPE members were dispatched. Oh no, this has turned into quite a mess…

—The following is our recent Balance Sheet (BS):

Debt Capital Definition: Other capital refers to funds borrowed by a company from other parties. This includes bank loans, bonds, accounts payable, and lease agreements.

Equity Capital Definition: Equity capital refers to funds raised internally by a company or provided by shareholders. This includes equity issues and retained earnings.

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Assets		Liabilities	
Current Assets		**Current Liabilities**	
Item	Amount	Item	Amount
Cash and deposits	10,000	Notes and accounts payable trade	110,000
Notes and accounts receivable	70,000	Short term loans payable	450,000
Inventories	180,000	Current portion of long term debt	80,000
Other current assets	10,000	Other current liabilities	40,000
Total current assets	270,000	**Total current liabilities**	680,000
Fixed assets		**Long term liabilities**	
Item	Amount	Item	Amount
Buildings and structures	120,000	Long term debt	300,000
Machinery, equipment and vehicle	90,000	Bonds payable	20,000
Land	80,000	Allowance for Pension.etc.	30,000
Other tangible fixed assets	20,000	Other Long term Liabilities	20,000
Goodwill	0	**Total Long term Liabilities**	370,000
Other intangible fixed assets	10,000	**Total liabilities**	1,050,000
Investment securities	20,000	**Total net assets**	
Other investment assets	10,000	Item	Amount
Total fixed assets	350,000	Capital stock	100,000
Total assets	620,000	Capital surplus	50,000
		Retained earnings	△580,000
		Total shareholders' equity	△430,000
		Total net assets	△430,000
		Total liabilities and net assets	620,000

The **Pm** intervened: —Our recognition of significant problems is Cash Flow (CF) shortages. Our Accounting Manager shouted, "We have no cash", "We are on the brink of bankruptcy". We cannot forget this message. Then, shall we discuss CF first in the Balance Sheet?

—Yes —the **Mp** agreed—, it is a big problem. But the cause of Cash Flow shortages is the issue of Inventory, isn't it? Therefore, why not look at the problem first in BS?

The dialogue continued for a while, and then **Af** tried to clarify: —OK, ok, ok. Let's look at these. But please understand the other and more serious problem, which I said was "already bankruptcy". We are in Insolvency (in excess of debt) —and he continued the lengthy exposition...

—Insolvency, Cash-Flow, Inventory. Anyway, these are deeply related. Then, let's start with the Inventory issue, do we? …

Introduction

—Please look at the material for the Balance Sheet. There are two sides: the left-hand side (**Assets**) and the right-hand side (**Liabilities**).

—One of the rules is that the bottoms (Total assets and Total liabilities) must be the same numbers…

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—The Balance Sheet is a financial statement that summarizes the economic condition of a company at a given point in time, including the status of its assets and the breakdown of financing to obtain them. Along with the income statement (P/L Statement) and the statement of cash flows (CF Statement), it is one of the three financial statements. All companies must prepare a balance sheet at the time of closing…

—By the way, let me explain a few specific examples and characteristics of an unhealthy Balance sheet…

—An unhealthy Balance Sheet is an essential indicator of a company's weak financial position. Here are four specific examples and general characteristics —the **Af** continued his exposition as follows:

(1) High degree of dependence on borrowings

A healthy balance sheet is considered to have a borrowing dependency ratio of less than **50%**, but in the case of an unhealthy one, this ratio is often more than **70%**. This increases repayment pressure and makes the company's financial position unstable.

Our company's numbers will be looked at later in this section.

(2) Decline in the current ratio

The current ratio is current assets divided by current liabilities. It should be **at least 100%**. If this is low, cash flow will be tight, indicating short-term solvency problems.

Assets		**Liabilities**	
Current Assets		**Current Liabilities**	
Item	Amount	Item	Amount
Cash and deposits	10,000	Notes and accounts payable trade	110,000
Notes and accounts receivable	70,000	Short term loans payable	450,000
Inventories	180,000	Current portion of long term debt	80,000
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(3) Low equity ratio

A significantly low equity ratio, e.g., less than **30%** increases the risk of bankruptcy because liabilities are large relative to assets. Such companies have difficulty raising capital, and their financial health is impaired.

(4) Excess inventory

Excess inventory can adversely affect liquidity because funds are tied up in the inventory. This leads to a loss of Cash Flow.

Inventory

Let's examine the item in inventory. As you know, our Inventory Turnover is becoming worse and worse. According to the recent data, it has recorded 2.0 turns. (Shorthand method calculation)

Inventory Turnover (From TQM-11).

I know it's a bit late to say this, but the calculation formula is next:

$$Monthly\ Inventory\ turnover\ = \frac{Montly\ sales\ ammount}{\begin{matrix} actual\ inventory \\ (monthly\ record) \end{matrix}}$$

However, I believe you are aware that this is a shorthand method.

The true calculation is as follows:

$$Inventory\ turnover\ = \frac{Cost\ of\ Goods\ sold}{\begin{matrix} actual\ inventory \\ (monthly\ record) \end{matrix}}$$

My target companies are manufacturing companies. And in most cases, it is possible to see that the figures for Sales amount are close to the Cost of Goods Sold. At the very least, it is possible to see the trend. Then, I teach this shorthand calculation.

—And as you know, the result is 2.0 turns —the **Af** concluded.

—Yes —the **Hr** agreed—, at the last time, I reported this figure. Once again, our Inventory Turnover ratio is 2.0. The meaning of this figure is:

1 turn takes about 182.5 days (= 365 ÷ 2.0)

—It is a money-based amount. Then, the total inventory amount of money is turned 2 twice per year. Another point of view. Unfortunately, our warehouse has stopped the visual control of

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Obsolescence, Excess and Normal stock by colour tags. Therefore, we cannot understand how many of and how much of the above categories are in the inventories. It is pretty easy to assume that there are many obsolescences and an excess of inventories. And cash is frozen in these stocks.

—It is right —**Af** agreed—. And let's look at this figure in BS where the inventories are 180,000. -

Assets		**Liabilities**	
Current Assets		**Current Liabilities**	
Item	Amount	Item	Amount
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		Total net assets	△430,000
		Total liabilities and net assets	620,000

- Abnormal inventory levels: Inventories are 180,000, or 29% of the total assets for 620,000. -
- And as explained, inventory turnover is about 2.0 times/year, which is very low for a manufacturing company like ours.
- Inventories as a percentage of current assets: Inventories account for about 66.7% of total current assets (270,000), which is a low liquidity asset mix.
- Difficult-to-cash assets: Excess inventory is likely to be unable to be converted to cash according to its book value, and its real asset value may be lower than the value on the balance sheet. Stale Inventory.

—Mumm —the **Sm** muttered—. I got it (maybe). Mumm.

—Ok. Once again —explained **Af**—. Vicious Cycle of Excess Inventory and Financial Condition. Our company is in a vicious cycle of:

1. Fixed working capital due to excess inventory: cash flow deterioration because funds are locked up in excess inventory and cannot be converted to cash holding on to inventory that cannot be sold, further reducing the value of inventory. Thus, Inventories are 180,000.
2. Financing inventory with debt: Increased borrowings due to Funding of inventory with debt Unable to repay debt because inventory is not selling. Short-term loans

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payable are 450,000, and Long-term liabilities are 300,000. The headquarters make these loans. And they already said, "No more".

3. Dependence on rollover (refinancing) of short-term debt: Dependence on rollover (refinancing) of short-term borrowings: Cyclical operation to repay short-term borrowings that cannot be repaid with new short-term borrowings

—In general, —the **Af** tried to conclude— a crisis occurs when a financial institution's credit limit is reached and the company is unable to take out new loans. Again, in our case, the head office has informed us that it cannot provide any additional funds.

—Ok —the **Sm** understood—, I got it. But indeed, I'm very sorry.

The **Af** enhanced his explanation: —In addition, let's look at key financial indicators and excess inventory:

1. Equity ratio: **-69.4%**
   (Total net assets -430,000 ÷ Total assets 620,000 × 100)
2. Debt dependency ratio: **133.9%**
   (total debt: 830,000 ÷ total assets: 620,000 x 100)
3. Current ratio: **39.7%**
   (Current assets 270,000 ÷ Current liabilities 680,000 × 100)
4. Current ratio: **11.8%**
   (current assets 80,000 ÷ current liabilities 680,000 x 100)
5. Inventory turnover period: **2.0**.
   (Inventory: 180,000. Average monthly sales: 360,000)
   Inventory Turnover = 360,000 ÷ 180,000 = 2.0

—In order to improve our company's situation, we need to take drastic measures such as disposal of excess inventory (e.g., discount sales and inventory write-downs), debt restructuring (e.g., requesting debt forgiveness from headquarters, DES), and business restructuring.

—Sorry for my ignorance —the **Mp** broke the speech—. But please allow me to ask a stupid question. Could somebody please explain the meaning of this figure of Inventory Turnover 2.0? I know, I know. However, I'm a bit confused.

The **Hr** tried to explain it in deep: —What do we mean by an Inventory Turnover of 2.0 in the manufacturing industry? It is when the Inventory Turnover 2.0 for a company, with low gross margins in the manufacturing industry, means the following:

> Basic Interpretation of Inventory Turnover 2.0: An Inventory Turnover 2.0 means that the average inventory turns 2 times in one year (12 months). In other words, it takes, on average, two cycles per year for inventory to turn into sales (or cost of sales).
>
> Each inventory cycle takes about 6 months (365 days / 2 = 182.5 days). On average, inventory is held for about 6 months.

—Am I right Mr. **Af**? —Hr asked him.

—Yes, it is correct —**Af** agreed—. Let's look at the Evaluation of Inventory Turnover Ratio 2.0 from a financial perspective:

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An inventory turnover ratio of 2.0 is low for many manufacturing industries and may have the following financial implications:

- **Fixed working capital:**
  A large amount of capital is tied up in inventory, and our company is a typical **example of this situation, with 180,000 tied up.**
- **Impact on cash flow:**
  An extended period of time between the purchase of raw materials and the collection of funds from product sales. And it may become a cash flow pressure factor. As I have mentioned many times, our company is financially constrained.

—Everyone —**Af** requested all their attention—, I know this is not just my feeling, but I have misinterpreted the relationship with the head office. I believed that our company was one business unit of the parent company and that we could always get assistance from headquarters.

—One business unit. I believe this is correct. But the head office also sees us (rightly so) as an independent company.

—I also thought in the same way —the **Em** mentioned.

Following the exposition, the **Af** continued: —Now….

- **Increase in inventory-related costs:**
  Increased storage costs (warehousing costs, insurance, etc.)
  Increased risk of obsolescence and quality deterioration.

—How do you think so many and so much inventory? —he finally asked them.

—I think there are 2 causes —the **Sm** delved deeper—: One is that the business model has changed. After our Managing Director took up his post, the business underwent a change. Initially, the main sales were the series of the main products. It could be sold in large volumes by one business.

—But as you know, such a business has gone. And our Managing Director declared to make business based on market conditions. Such as products. H, W and L series. These are minimal dealing lot sizes. But the profit margin is good. Also, there is the market.

—The factory cannot follow this change yet. I know, the factory is making an effort to catch up with this business model change. I know. But still, the production lot size is too large. He cannot produce one by one or order by order. He makes 50 for only a 5-piece order. Additionally, it is not possible to consistently gain the same orders by month.

—If you say so, there is another additional reason for the increase in inventory —the Em questioned and after a slight dramatic pause, he continued—. Design change —he stopped for a while again to see the other person's reaction, and then he continued...

—When looking at the trend of the number of design changes by one product, it is clearly increasing. In other words, the life cycle of one product is becoming shorter. It is indeed our business that has been transformed into "high-mix low-volume production." But unfortunately, the factory cannot keep up with its changes…

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—I had a dialogue with Kimura Sensei. He is an expert in TPS and JIT production. And he said with a laugh: "You don't need my suggestion, because your Production Manager knows how to do it". Additionally, he said, "Please discuss with your Production Manager to confirm the strategy and policy of this company and the agenda".

—I see —the **Af** show a bit of concern—, I could understand the reason why the inventory is increasing. Humm. Well, shall I continue the explanation of the Balance Sheet?

—Oh, yes, please —requested the **Em**.

The **Af** continued: —Ok, the Next issue is the Cash Flow Shortages. I suggest that you once look at the Cash Flow Statement…

—The Cash Flow Statement is one of the three pillars of financial statements…

Cash Flow Statement, Balance Statement, and Profit and Loss Statement

Purpose: to show the flow of cash in and out of the company over a period of time. Its composition is as follows:

- Cash flows from operating activities, i.e., cash flows from the core business
- Cash flows from investing activities, i.e., capital expenditures, asset sales, etc.
- Cash flows from financing activities, i.e., borrowings, repayments, dividends, etc.

These are looked at.

—Anyway, we can discuss this on another occasion —the **Af** concluded.

The **Pm** expressed an interesting observation: —I can't get this word out of my head. As "No cash", "We are on the brink of bankruptcy" was expressed by our Managing Director. And I think I understand the situation. But once again, I wish to confirm it on the Balance sheet.

—Ok —the **Af** agreed to explain on the Balance sheet—. Let's look at this situation. First, I need to tell you that it is not directly equivalent to Cash Flow Short-term to bankruptcy.

—What is bankruptcy? —asked the **Af** to the rest of the managers, and without waiting for an answer—, the Legal Definition of Bankruptcy: Legally, bankruptcy primarily refers to the following situations. Inability to pay: a general inability to fulfil debt obligations…

—In the meantime, Insolvency means a condition in which liabilities exceed assets (if ongoing)

—So, a cash flow shortfall does not necessarily lead directly to the above states. And we are in both. The parent company provided financial support, debt guarantees, and other capital injections…

—But as you say, the term "cash flow bankruptcy" is an essential concept in the field of management practice and bankruptcy research. Cash flow bankruptcy refers to a bankruptcy that occurs

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when the actual flow of cash (cash flow) is stagnant, even though the financial statements show a surplus or sound financial position.

—Specifically, the situation is as follows:

- Profit in the P/L (Profit and Loss Statement)
- The Balance Sheet shows that the company is not insolvent.

—However, due to a mismatch in the timing of cash inflows and outflows, there is a shortage of cash to meet payment deadlines.

—Unfortunately, our company is in the Red in P/L and insolvent in our Balance Sheet.

The **Pm** laughed and asked the group: — How could we do that. Is there a meaning to continuing ***Jishu-ken***? —and he continued laughing with a bittersweet face —and he asked again to the group—. DOPE? …Ha, ha, ha…

—As ***Sensei*** said —the **Em** pointed out—, we need to confirm it without the Managing Director of the company's strategy and policy. I think it is pretty straightforward without waiting for his answer. We are in a business transformation. And the answer is the business in "High-mix low-volume". Fortunately, there is an abundant market. Therefore, I would like to introduce the latest equipment for catch-up high-mix, low-volume production. But it was stopped by DOPE…

—Mr **Pm** —The **Hr** begged—. Don't be so pessimistic. Anyway, let's continue with the explanation from our Accountant staff.

The **Af** continued his dissertation: —Cash flow bankruptcy is a typical form of "surplus bankruptcy. In other words, it is a case in which a company experiences a cash shortage that leads to bankruptcy, despite having posted a profit in accounting terms. But as we will see later, our company is already insolvent. If we do not receive financial support from the head office as we have been doing, we will go bankrupt tomorrow.

—Daring to use the term cash flow bankruptcy, the danger of cash flow bankruptcy can be read from the Balance Sheet. So, there are some signs, such as a:

I. Declining in the current ratio:

Current assets divided by current liabilities is less than 100%

Total Current asset = 270,000.

Total liabilities = 1,050,000

(270,000 ÷ 1,050,000) x 100= **25.7**

Short-term insolvency

$$\boldsymbol{Decline\ in\ current\ ratio} = \frac{Cash\ \&\ deposits\ +\ Accounts\ receivable\ +\ Other\ current\ assets}{Total\ Current\ liabilities.}$$

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Indicates immediate solvency: below 100% is a danger signal

Cash and deposit = 10,000.

Accounts receivable = 70,000.

Other current assets = 10,000.

$$\textbf{\textit{Decline in current ratio}} = \frac{10{,}000 + 70{,}000 + 10{,}000}{680} = \mathbf{13.2}$$

Assets		Liabilities	
Current Assets		**Current Liabilities**	
Item	Amount	Item	Amount
Cash and deposits	10,000	Notes and accounts payable trade	110,000
Notes and accounts receivable	70,000	Short term loans payable	450,000
Inventories	180,000	Current portion of long term debt	80,000
Other current assets	10,000	Other current liabilities	40,000
Total current assets	270,000	**Total current liabilities**	680,000
Fixed assets		**Long term liabilities**	
Item	Amount	Item	Amount
Buildings and structures	120,000	Long term debt	300,000
Machinery. equipment and vehicle	90,000	Bonds payable	20,000
Land	80,000	Allowance for Pension.etc.	30,000
Other tangible fixed assets	20,000	Other Long term Liabilities	20,000
Goodwill	0	**Total Long term Liabilities**	370,000
Other intangible fixed assets	10,000	**Total liabilities**	1,050,000
Investment securities	20,000	**Total net assets**	
Other investment assets	10,000	Item	Amount
Total fixed assets	350,000	Capital stock	100,000
Total assets	620,000	Capital surplus	50,000
		Retained earnings	△580,000
		Total shareholders' equity	△430,000
		Total net assets	△430,000
		Total liabilities and net assets	620,000

The **Af** continued his exposition: —By just this signal, our company is on the brink of bankruptcy. This situation was allowed for many years by the headquarters. But at this moment, it was stopped. Then, he dispatched the DOPE.

—I will continue the explanation:

II. Declining trend in cash deposits:

Continuous decrease in cash deposits over multiple periods. It is just hazardous when it falls below one month's worth of monthly sales (average monthly sales)

The **Mp** intervened: —And the Inventory (180,000) contributes to the Cash-flow problem, Short-term loans payable (450,000), and Current portion of long-term debt (80,000), right?

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—Mumm —the **Af** hesitated—. The problem of Inventory is serious. But the worsening of performance is not just about Inventory. But the issue of Inventory is serious because of the risk of disposal due to obsolescence.

—Therefore —the **Em** tried to build a conclusion— , it is necessary to change or improve the production system from batch production to 1 by 1 production. Our production line is designed for high-volume batch production. We need to change to the style of High-mixed low-volume production quickly…

—Therefore —and he repeated with some hesitation—, therefore…, I planned to replace the current old-style machines by introducing the latest machines…

—This model's Turning Centre have the function of Turning, Milling, Drilling, Threading, Grinding, Gear cutting, and Polishing…

—As you know, our products have many machining processes. And each process is a batch production and has WIP (work-in-process). I believe it is included in the Inventory of BS (180,000), as we are conducting the monthly inventory check. Look at our factory. We're overflowing with WIP items. Consider the inventory turnover rate, currently at 2.0…

—So alarming! One of the causes is too much WIP on the shop floor. Therefore, it is necessary to reduce the process by introducing the turning centre machine. Of course, I know it is essential to invest a certain amount of money. But it is necessary to invest.

—Ok, Ok —the **Hr** admitted—, we got it, your opinion. But this plan was stopped by the DOPE.

And then he asked Em: —Did you have a conversation with Sensei?

—Yes, we did. When Mr. Mp and I had a dialogue with Sensei regarding the latest machine (Turning Centre) buying plan, which DOPE stops, he gave us the following advice:

The following is the contents of the dialogue with me and Mr. **Mp**. (From Making stream of production-12)

> *—Why do we need such machines? —Kimura Sensei asked us.*
>
> *The I (**Em**) answered: —It is necessary to catch up with the business change (to High-mix, low-volume production).*
>
> *—Sensei, as you already know, our business circumstances have been dramatically changed. We need to deal with and catch up on this issue.*
>
> *—High-mix and low-volume production. By a changeover increase. Down time increases. Production capacity down. Quality concern increases. WIP increase. And factory performance is down.*
>
> *—We are producing 50 pieces for 3 actual order numbers. (It was an exaggerated example. But there was such a case, actually, too.)*
>
> *—Sensei —I begged—. We need to deal with such problems. Therefore, this latest machine is necessary. This machine has 8 chucks. And it is possible to prepare the jig*

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*tools installation by **Mae-Dandori** (Before-Changeover). And, we can expect the time reduction regarding the above problems. Is our investment, right?*

—It is a serious issue by us, because of so long LT (Lead Time). By introducing this type of machines, we can expect reduction of process (exaggerated example; 8 processes to one.)

—I see —Kimura Sensei admitted—. Changeover frequency is dramatically increasing due to High-mixed low-volume production. That's tough! And? …How do you resolve such problems as the person in charge of engineering and production?

—Because you stopped this plan by DOPE, weren't you?

*—Therefore, we need your advice —the **Mp** requested.*

Making the Stream of Production 0-14 (Lecfure 12 - view in Internet Archive)

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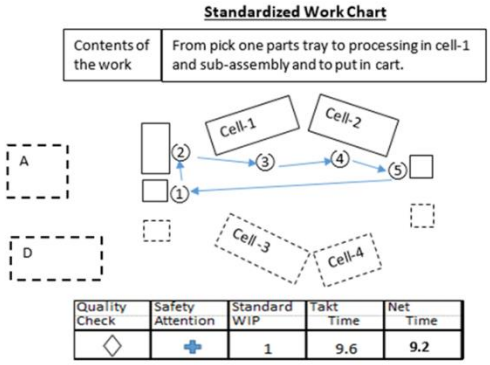
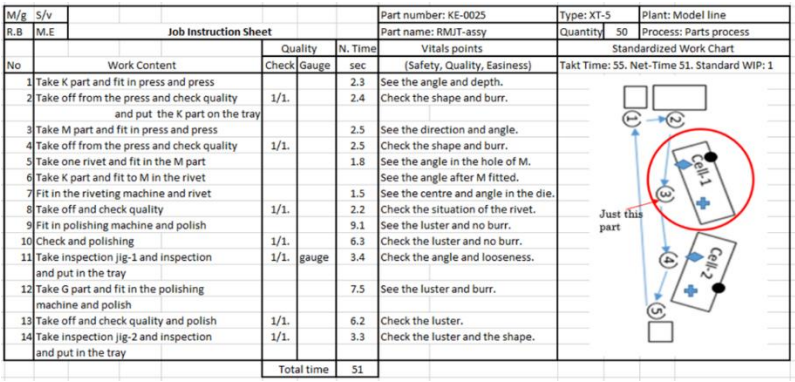
—So…? —The **Hr** asked **Em**—. What happened then?

—There was no answer —the **Em** admitted—. And, instead of an answer, he gave us the following photo. And he requested us to think which is better for us, 1 by 1 production or batch production.



—And once again, I asked to explain the pictures to us. But he was smiling and requested us to visit and explain them to him next week.

—Ah… —the **Sm** admitted—, makes sense! It is one part of the Toyota Production System and the so-called one-by-one production (one-piece-flow). I see. Sensei recommends that we consider the one-by-one production system.



M/g	S/v				Part number: KE-0025	Type: XT-5	Plant: Model line
R.B	M.E	Job Instruction Sheet			Part name: RMJT-assy	Quantity 50	Process: Parts process
			Quality	N. Time	Vitals points	Standardized Work Chart	
No		Work Content	Check Gauge	sec	(Safety, Quality, Easiness)	Takt Time: 55. Net-Time 51. Standard WIP: 1	
1		Take K part and fit in press and press		2.3	See the angle and depth.		
2		Take off from the press and check quality and put the K part on the tray	1/1.	2.4	Check the shape and burr.		
3		Take M part and fit in press and press		2.5	See the direction and angle.		
4		Take off from the press and check quality	1/1.	2.5	Check the shape and burr.		
5		Take one rivet and fit in the M part		1.8	See the angle in the hole of M.		
6		Take K part and fit to M in the rivet			See the angle after M fitted.		
7		Fit in the riveting machine and rivet		1.5	See the centre and angle in the die.		
8		Take off and check quality	1/1.	2.2	Check the situation of the rivet.		
9		Fit in polishing machine and polish		9.1	See the luster and no burr.		
10		Check and polishing	1/1.	6.3	Check the luster and no burr.		
11		Take inspection jig-1 and inspection and put in the tray	1/1. gauge	3.4	Check the angle and looseness.		
12		Take G part and fit in the polishing machine and polish		7.5	See the luster and burr.		
13		Take off and check quality and polish	1/1.	6.2	Check the luster.		
14		Take inspection jig-2 and inspection and put in the tray	1/1.	3.3	Check the luster and the shape.		
			Total time	51			

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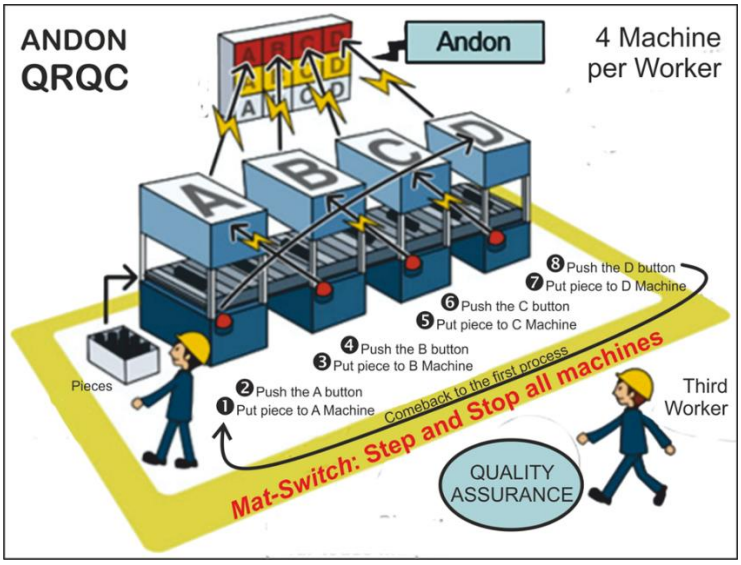

—I know it and thought so. But I need to prepare the answer on how we can realize it by the next meeting with him —the **Em** mentioned and continued….

—Of course, it is necessary to prepare and answer other ideas if we don't adopt this 1 by 1 production. Anyway, the current situation isn't acceptable to DOPE and Headquarters. Also, DOPE is hostile to the idea of the latest machine investments.

—LT reduction, Changeover frequency reduction, Changeover time reduction —the **Af** detailed—. For adopting High-mixed low-volume production and one-by-one production. Humm.

—Yes —The **Mp** agreed—, that's right. Not only us, but also the factory should be changed.

—Anyway, everyone —the **Pm** requested—. Shall we continue the discussion of the Balance Sheet now?

—Oh yes —the **Em** pointed out—. Sorry, Mr. **Af**. Please continue it.

—Ok —the **Af** continued—. Last item is Insolvency.

- Insolvency.
  First, I would explain what the situation is in our Balance Sheet.
  Insolvency is one of the most clearly discernible problems on the BS.
  Simply put, insolvency is a situation where the total assets are less than the total liabilities. On the BS, it appears in the following areas:

  Total assets ＜ Total liabilities. Let's look at our case:

  Total assets: 620,000. Total liabilities: 1,050,000

  The BS equation "Assets = Liabilities + Net Assets" is broken and becomes;

  Liabilities: 1050,000. Net Assets: △430,000.

  "Assets = Liabilities - Net Assets"

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If the total assets on the left side of the BS minus the total liabilities on the right side of the BS is negative, the company is insolvent. The same applies if the total of net assets is shown as a negative figure.

Assets		**Liabilities**	
Current Assets		**Current Liabilities**	
Item	Amount	Item	Amount
Cash and deposits	10,000	Notes and accounts payable trade	110,000
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Other investment assets	10,000	Item	Amount
Total fixed assets	350,000	Capital stock	100,000
Total assets	620,000	Capital surplus	50,000
		Retained earnings	△580,000
		Total shareholders' equity	△430,000
		Total net assets	△430,000
		Total liabilities and net assets	620,000

- Serious insolvency situation

  Significantly negative Net assets: Total net assets are △430,000, a negative amount of approximately 69.4% of Total assets (620,000).

  Liabilities significantly exceed assets: Total liabilities (1,050,000) are approximately 1.69 times Total assets (620,000).

—Anyway, our plant is like a zombie; Zombi company —the **Af** concluded.

The **Pm** requested a clarification: —Mr. **Af,** just a little more. Please let us know the meaning of Retained earnings △580,000. How can we understand this vast amount of money? Is this accumulated deficit, isn't it?

—Yes —the **Af** agreed—, as you say. Negative retained earnings (in negative △ notation) indicate an accumulated deficit.

The **Af** continued his explanation: —For reference, the relationship between Negative Retained Earnings and an accumulated deficit is… Let me explain the basic concept.

Retained earnings represent the balance of accumulated profits (or losses) earned through business activities since the company's

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foundation, minus the amount that has flowed out of the company, e.g. through dividends.

Negative Retained earnings mean that: The total amount of losses incurred is greater than the total amount of profits earned by the company.

This means that, cumulatively speaking, our company is in the red. I'm afraid these year-end financial statements. Because it is required to dispose of stagnant inventory (obsolescence inventory). Our monthly P/L Statement shows black. But unfortunately, recently, the year-end disposal of obsolescence has become the norm. And this is the leading cause of the accumulated red shown in the Negative Retained Earnings.

The **Pm** requested then: —So, once again, I would confirm the meaning of Negative Retained earnings:

Retained earnings △580,000' means 'retained earnings minus 580,000.

—This means that there is an accumulated loss of 580,000. Correct? —The **Pm** asked then again—. And, what are retained earnings?

—Yes —the **Af** answered then—. Retained earnings are the accumulated profits earned by the company since its foundation that have been maintained within the company without being distributed to shareholders. As an aside, it mainly consists of the following items:

Legal reserves: reserves required to be set aside by the Companies Act.

Voluntary reserves: funds set aside for specific future purposes.

Retained earnings brought forward: Unappropriated retained earnings other than those mentioned above that are carried forward to the next financial year.

—Ok —the **Pm** understood—. Let me explain to confirm my understanding.

Situation indicated by negative retained earnings:

1- Existence of accumulated losses: Indicates that the company has accumulated losses of △580,000 from past to present business activities

   The total loss incurred is △580,000 more than the total profit earned in the past.

2- Serious business situation: This significant accumulated loss suggests that the company may have been operating at a loss for an extended period.

   The accumulated losses of △580,000 are severe. al surplus of JPY 50 million.

3- Main causes of insolvency: Total net assets of △430,000.

This significant accumulated loss is the leading cause of insolvency.

The Impact on financial statements:

1- Impact on net assets: If retained earnings are negative, net assets are reduced by that amount.

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—If the negative amount exceeds the sum of capital and capital surplus, the overall net assets become negative and the company becomes insolvent. Correct? —the **Pm** asked **Af**.

—Yes —the **Af** confirmed—. Please, continue —requested to **Pm**.

Leading causes of Negative Retained Earnings are:

1- ongoing business losses: Long-term operating losses due to a decline in the profitability of the core business or deterioration in market conditions.
2- a cost structure that is not in line with sales and has a high fixed cost burden
3- large extraordinary losses: Particularly the year-end disposal of surplus inventories. e.g. inventory write-downs, write-downs of excess inventory, etc.

—Huuu…! —the **Em** requested a stop for a while. We understood our standing position by BS understanding. Huuu….!

—How can we do? What should we do? …DOPE?

—DOPE also isn't just telling us bad things —the **Af** pointed out, and continued…

—For instance, he requests that we (the indirect departments) reduce staff by 30% by improving the working methods. And, my department has been trying to introduce digital transformation in the working process. But 30%. It is too rushed.

—Everyone, please —the **Sm** requested—, don't be pessimistic. Dim, but we have discovered the light. And we are challenging to the corporate structural reform. High-mixed low-volume production and receiving orders. We need to catch up on it. Right?

The **Em**; agreed: —Yes, Mr. **Sm**, You are right. I'm clear that our biggest enemy is the constitution of Inventory. And its basic cause is the batch production. Everyone, now I'm clear and do not doubt my direction; minimal lot production in a one-by-one flow of production. Unfortunately, the plan for the latest machine investment was stopped by DOPE...

—I will have a meeting with the ***Sensei*** regarding the photos which he gave us. These photos show us the possibility of a one-by-one flow of production.

—By the way… —the **Em** come up with a suggestion—. Shall we expand this ***Jishu-ken*** to a project activity involving other departments?

—A one-by-one flow of production with linking to a High-mixed low-volume receiving order. Receiving orders and transformation to the production line. Edge computing system. A one-by-one material delivery system by the warehouse. Inspection system in a one-by-one production flow. Minimum stock and/or direct shipping from production line to customer. Design change feedback to the production line. Accounts receivable by customers. Machine maintenance system. “All people’s participation” corporate culture, Kaizen mind, Education and training. Skill evaluation. Necessary investment. etc. etc.

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—Wait a minute. What paper are you reading? —the **Hr** asked **Em**.

Just a little grinning, the **Mp** answered him: —When we made the dialogue with the ***Sensei***. There were these phrases. And Mr. **Em** made

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these shorthand notes. Anyway, it is pretty clear that this reform is necessary to involve all departments. DOPE? It is not necessary to cause any disturbance by involving them.

—Interesting —the **Hr** pointed out—. And? Is there other dialogue with the sensei?

—Actually, it seemed I didn't look well… when we met him —the **Em** asked the group, and without waiting for an answer, he pointed out—: And… he said something cryptic to me:

> —Mr. **Em** —Kimura ***sensei*** requested me—, How many years of experience do you have as an engineer?
>
> —Well, I have 23 years of experience.
>
> —Ok. Now, I advise you to think for one minute in bed before sleeping. Alright, just one minute, okay? One minute. Keep it light. Then go to sleep.
>
> —Just before you go to sleep, think about the topic that's been bothering you. This is something I actually do regularly. If you think about it for too long, you won't be able to fall asleep. Just think about the unresolved issue for one minute and then go to sleep. Just one minute is fine. Ok?
>
> —If you like, please come to see me a few days later.
>
> —Today? Now? You cannot. Not me, but you. Take a rest and DMN time.
>
> —DMN time? —I asked the Kimura ***Sensei***.
>
> —It's fine, just leave from the work.
>
> Then, 3 days later, I visited his office and had a small discussion. Of course, in 3 days, I implemented his suggestion of "One minute thinking in bed before sleeping". And we made the following dialogue.
>
> —How about your condition? —Kimura sensei asked me.
>
> —Today, much better —I answered him.
>
> Then, he asked me: —And… What do you want? Did you confirm what you should do?
>
> —Oh, yes.
>
> —Firstly, what I wish to do. The answer is the reduction of Inventory, including WIP (work-in-progress). The root of all evil lies in the Muda (waste) caused by overproduction. Now we are changing the business model from large-sized lot production to High-mixed low-volume production. Additionally, the design change cycle is becoming quicker due to the trend of customized products.
>
> —Secondly, how to realize it. The answer is establishing a one-by-one production flow.
>
> —I see —Kimura ***Sensei*** nodded—. If you have decided your way, it is a good thing. And now… How can you realize it?

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—Everyone —**Em** requested— One-by-one production flow. As we confirmed, we aim to transfer to High-mixed low-volume production. This is the reform of our plant.

—Ok —the **Sm** questioned then—: We agreed with you. And? What were the cryptic words?

—Oh, yes. It is also a recommended item for you: One minute. Keep it light and think about the topic. The key words are One-Minute Thinking, Idle Brain, and Intuition. And that is what the Sensei said:

> "*What should we do when we are unsure of the solution to a problem? One article stated. Trust your intuition. It is the optimum solution that the supercomputer called 'brain', which you have cultivated from birth to the present day, has come up with*".

—Interesting —the **Hr** admitted—, it is. Do we have a supercomputer? Our brain is a supercomputer. Oh, I see.

The **Em** confirmed his words: —That's right. Our brain is a supercomputer. And it has the accumulated knowledge by my age. This knowledge is sleeping in the brain. But it is necessary to dig up efficiently.

—When we have a theme of thinking, Kimura ***Sensei*** told me that there are 2 methods of brain thinking. One is the use of DMN (Default Mode Network). Another is Idling Brain.

—The method to use DMN is, anyway, like a walk. (Please refer TQM-6) Sensei said and recommended us one-minute DMN in the toilet. It is indeed interesting. In the toilet, and after you're done with 'whatever' in the toilet, take a minute to relax and zone out. He calls it a "one-minute meditation". Cho-Shin (調身), Cho-Soku（調息）, Cho-Shin（調心）. It is the mantra.

The **Pm** showed an incredulous face: —That's a unique idea. Meditation in the toilet!?

—Oh, one-minute meditation. In the toilet. Oh, I see —the **Sm** understood and hesitated—: But. But… can we do it in the current toilet? Bad smell, Dirty, it is natural to think of escaping as soon as possible, no?

The **Em** pointed out: —And kimura ***sensei*** said next as well: "Seeking one-by-one production by JIT is a good direction for your business change. And, it is necessary to realize some themes (above his memorandum). But I can say that a factory that has a very dirty toilet cannot realize such themes, much less JIT".

—The toilet issue may be an exaggerated example by him. However, his word may be correct, if 'dirty toilet' is rephrased as 'bad 5Ss'. Anyway, one of his suggestions is to establish the 5Ss condition first —the **Em** mentioned.

Garbage in a Scrap can

What a dirty machine!

***5th Jishu-Ken* for Cost Reduction**
Em: Engineering Section Manager.
Pm: Production Section Planning Manager.
Mp: Material Section Procurement Manager.
Hr: Human Resources Staff.
Sm: Sales Staff.
Af: Accounting Staff

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—Oh, sorry, Mr. **Af** —the **Em** apologized—, such talking. It is not related to today's lecture on the Balance Sheet.

—No, not at all. I also have my interest in the business change, the reform factory, and the dialogue between you and Sensei. Please let me listen: Back to DMN.

—This method is the leaving from the thinking. ***Sensei*** said the following: "You have a huge capacity in your computer (brain). Then we need to do 2 things: One is to charge knowledge more and more. Another is to use it more sufficiently."

—He said that our use of the brain is not efficient.

—He advised you to do so! —the **Sm** nodded— Humm! One minute thinking. It may be easy to do.

DMN, Idling Brain and more

DMN

The DMN is a set of neural circuits that are activated when the brain is not concentrating on external stimuli. This network is particularly active during self-reflection, recollection of past events and planning for the future; DMN activity often contributes to inspiration and creativity, and thinking in a relaxed state is an essential factor in generating new ideas.

Idling Brain.

According to Sensei, the brain has the ability to instantly derive an answer that seems to be the correct answer, based on a few pieces of data (experience). This is what is known as "Inspiration and/or Intuition".

Against this is the method of one minute of thinking about the theme before sleep.

He said that we can and need to believe our Intuition. The brain can also think for itself, with a will, and create something new.

In short, the correct answer is meant to be in the brain; it is just a matter of bringing it to consciousness, and that's what we need to do.

Mind wandering and inspiration.

Please take a moment to zone out for a minute after you've finished defecating in the toilet.

But Toilet? …Why the toilet? Whether it's a teatime during a break, it can be anything. A moment of zoning out between tasks. This is beneficial for the full utilization of the brain.

Mind wandering is a state in which the mind is diverted from the present task and shifts to thoughts of the past or future. This state is an essential background for

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inspiration to occur. Research shows that during mind wandering, the brain's Default Mode Network (DMN) is activated, facilitating self-related thinking and introspection. This increases the likelihood that different information and experiences will be connected, and new ideas will be generated.

Why am I writing about brain issues in this work?

I'm worried about the power balance between humans and AI.

AI will replace 45% of the human labour market. And gradually, it is being realized. NHK (Japan Broadcasting Corporation) has already started the news announcement by AI. Interviews for hiring newcomers by AI were also popular. Simple medical diagnosis by AI is also familiar, etc., etc.

Recently, there was a word "Guguru" in Japan at 2024. The meaning of Guguru is the use of Google as a search engine to investigate something. But now there is no such word. Instead of Guguru, it is generally to use AI for the search engine.

According to a book, AI is expected to add USD 15.7 trillion to the global economy by 2030.

Now it is not possible to talk about our future without AI. According to a book, AI is expected to add USD 15.7 trillion to the global economy by 2030.

And now it is impossible to discuss our future without AI. I'm worried about.

In the near future (no, already), AI is becoming a tool for telling lies and spreading them widely and rapidly. How can we deal with such a crisis?

The answer is that human beings should be human beings. Indeed, is AI telling a lie?

No, it is not (so far). AI has been taught a lie by human beings. And, once again, " so far" and AI will be able to create a lie by itself.

How can we cope with? …What actions can we take to prevent the risk of AI running amok?

As we can think of them.

1- (after all) Deepen our knowledge of AI:

It is essential to develop an understanding of the basic mechanics and risks of AI; learning how AI works and what risks exist will help you make wiser decisions. For example, knowing how AI learns from data and makes decisions will help to develop a better understanding of its use.

2- Critical evaluation of information:

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It is important to have a critical perspective on AI-generated information and content. In particular, deepfakes and disinformation. Pay attention to the proliferation of these and get into the habit of checking the source and reliability of information.

3- Ethical (humanistic) sensitivities regarding the use of AI:

Develop a sense of the ethics and safety of AI. Expressing your views outwardly and exchanging views with others will help to deepen your social understanding of AI.

4- have their own policies on the use of AI:

Take an interest in the policies and regulations on the use of AI that companies and governments may develop in the future. This can encourage the development and use of AI to be ethical and safe. For example, raise your voice for transparency and accountability in AI.

And how can we be sound humans?

The answer is: **You should use your brain sufficiently by thinking in the environment, DMN, Idling Brain, and Mind Wandering**.

You have a supercomputer in your brain. Please use it sufficiently. But one of the essential things is to have a variety of experiences and learning. There is no supercomputer without expertise and knowledge.

—Then… —the **Hr** tried to make a conclusion—, you thought, thought and thought. And you drew out your thinking, which is to realize the one-by-one production system as the reform of our plant. Right?

The **Em** made an effort to summarize his thoughts: —Everyone —he requested attention—, our company has chosen the way of High-Mixed low volume order received and production. Therefore, we need to seek a method to respond to it. No inventory or minimizing inventory. Inventory is evil. And to respond to it, one-by-one production should be the answer, right?

—This has turned into a big problem —the **Mp** observed—. How can we do it? …Huuu…! —he muttered—. And you suggest the company-wide big project—he showed some concerns in his gesture.

The **Pm** tried to face a positive face: —I'm not negative to suggest such a companywide project. But I have a concern. We know nothing about such a production system. No knowledge and making suggestions. It may become irresponsible.

—My idea is to introduce TPS (Toyota Production System and JIT (Just In Time) system —the **Em** detailed—. Our Production Manager might have his knowledge, given that he speaks something like this. And he shows his will in his annual action plan, which has the idea of JIT introduction.

—However, however… —the **Pm** expressed concerns—, TPS and JIT respond to a Mass production of such vehicles. And we aim to react to High Mixed low-volume production. I'm also never hostile to the idea. But the automotive industry is typical of Mass production.

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Then **Em** clarified his point of view: —According to a book, TPS responds to BTO (Built-to-order), and many kinds of orders are in one assembly line.

—But, —the **Pm** insisted— so many kinds of orders are all similar products. The chassis, body, and engine, etc., are the same, aren't they? Our High Mixed low-volume products are not similar to the production of similar products. Therefore, I doubt the seeking of the TPS and JIT method.

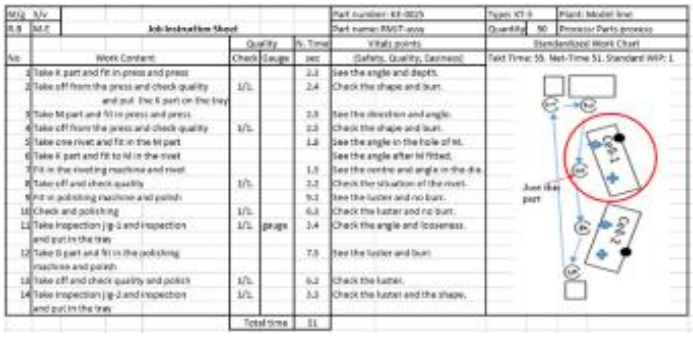
The **Em** expressed hesitation with a moan, but it was the **Af** who had come to help him: —Sorry, I don't have any knowledge about your talking theme, but isn't it possible to call our products similar to the production of other products and/or derivative models of the original products, aren't they? I have the opportunity to see the quotations. And it is possible to say that almost all products are constructed of the same or similar parts and materials.

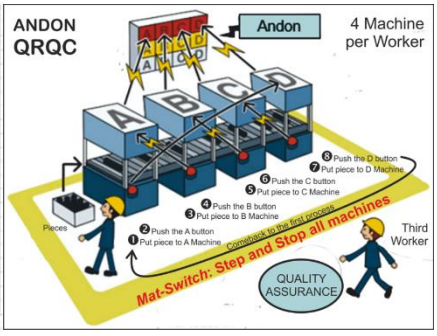
—Oh yes! —the **Pm** agreed—. The equipment, the tools, and also the techniques of assembly are almost the same for many kinds of products. However, when examining the individual processes, almost the same skills are required. Also, these are the derivative models of the original products. Of course, new model products are occurring. But current measurement production is almost entirely dependent on models. In this sense, our production is similar to car manufacturing, but with minimal processes.

The **Sm** agreed with him: —And my department also needs some ideas to contact customers. Looking at customers' requests is essential. But on the other hand, it is necessary to consider the condition of the production side. Such delivery date, divided delivery, receiving order lot size, etc.

—My department can also do something with combining the Sales department —the **Mp** pointed out—. For instance, consolidate orders for similar products.

—Thanks, everyone —the **Em** expressed his gratitude for sharing such a point of view—. Kimura Sensei gave us a hint on the following pictures:





—It is a hint for assembly process. And machinery processes.

—Probably, these are our solutions. However, and jumping to the other theme, I have to say sorry to our **Af** for jumping our central theme of the ***Jishu-ken*** session. And, thank you very much for your today's lecture about Balance Sheet —he expressed.

—No, not at all. I also could enjoy today's ***Jishu-Ken***.

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—So, everyone, please —the **Em** requested attention to close the session—. Shall we choose the next theme? One of the ideas is Cash Flow Statement…

—The Cash Flow Statement is regarded as one of the 'three financial tables' alongside the Balance Sheet and P/L Statement.

— I have a suggestion —the **Mp** requested—. Shall we study TPS and JIT? Mr. Em suggested the company-wide activity of TPS introduction. But before making this suggestion, I wish to learn TPS.

—It is an excellent suggestion, and I agree with Mr. Mp —the **Hr** nodded.

The **Sm** and **Pm** agreed with this idea as well; in the meantime, the **Em** jumped to the issue: —OK. Changing the theme. For the next session, we shall study TPS for responding to High Mixed low-volume production.

—Sorry, everyone —the **Af** asked the group as he was invited to this one extraordinarily—. May I ask you to accept me to join in that Jishu-Ken session as well?

This is how it goes: this company is challenging to realize TPS. And they chose TPS (Toyota Production System) introduction as the theme of ***Jishu-Ken***.

Actually, I already wrote this theme in Making Stream Production. But I will write again the theme through their activity.

IV. Following Lecture

We continue explaining the Taguchi Method. And Cost: Study of TPS.

Koichi Kimura, CC4 – September – 2025

International Consultant

Factory Management Institute

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V. Annex A: Torturing the data

A real-life example comes to mind that perfectly illustrates Sensei Kimura's reasoning regarding why the deepening of the statistical analysis techniques promoted by the Six-Sigma messiahs has its main limitation in a factor repeatedly mentioned in these recent readings: the level of factory management and creative thinking. Or, to put it another way, thinking that torturing data using statistical tools will reveal the causes of problems.

Among the 12 elements that make up the Factory Management checklist, the factors that determine ***Genba's*** ability to regenerate or improve itself (***Genba-Ryoku***[2]), there are some fundamental ones: the deployment of TQC/TQM, including visual management, process standardization using TWI, and the self-management capacity of multidisciplinary teams in ***Jishu-Ken***, or Quality Control Circles working in QRQC, and finally Hoshin-Kanri, or the Deployment and Control of policies. But achieving this ***Genba-Ryoku***, the 12th category that fosters a thinking environment, is critical.

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Factory management checklist

The 11 categories of the Management Level checklist		
Nº	CATEGORÍA	%
1	DEPLOYMENT AND CONTROL OF POLICIES	0%
2	ORGANIZATION AND ADMINISTRATION	0%
3	DEVELOPMENT OF HUMAN RESOURCES	0%
4	COLLECTION OF INFORMATION, TRANSMISSION AND USE	0%
5	STANDARDIZATION	0%
6	COST CONTROL SYSTEM	0%
7	FACTORY MANAGEMENT SYSTEM	0%
8	PRODUCTION CONTROL SYSTEM	0%
9	CONTROL OF MATERIAL	0%
10	QUALITY CONTROL SYSTEM	0%
11	ENVIRONMENTAL CONTROL, SECURITY, WORK ENVIRONMENT	0%
12	THINKING ENVIRONMENT	0%
TOTAL		**0%**

Factory Management Checklist V.2023

Contrary to Western belief, the Black Belt expert is not an expert in the process, but rather in statistics and some other quality control and/or project management tool. I have rarely seen these experts spend more than an hour a week in the ***Production Genba***. They are well-versed in some complementary software tools. For example: Minitab ©, PowerBI ©, Excel ©, and/or PowerPoint ©, plus perhaps a project management tool. However, torturing data doesn't usually lead us to any conclusions, at least in my experience.

[2] ***Genba-Ryoku*** is an expression of Kimura Sensei, but the regenerative ***Genba*** is not only his idea; Taichi Ohno also mentions this element through the expression: The ***Genba Nerve***, referring to the ***Genba*** nervous system capable of acting and improving on its own. In this regard, Ohno mentions this nerve on numerous occasions and the need for its development to achieve a ***Kaizen*** environment. It is interesting that it is mentioned, but not an element that is part of the TPS house. It is certainly an important detail to study, whether Ohno forgot to draw it or it is already implicitly in the TPS house.

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Dr. Deming himself insisted on the perverse effect of advanced statistical tools. According to his wisdom, in business, and particularly in the operations area, only basic statistical control tools are necessary: control charts, histograms, Pareto charts, scatter diagrams, and process capability analysis. He insisted that advanced statistics are indeed more useful in other cases, such as predictive, scientific, or primarily academic environments. These same assertions can be seen in other quality gurus: Walter Shewhart and Donald J. Wheeler.

Walter Shewhart is known as the "father of modern quality control" for his pioneering work in statistical process control, particularly the development of the control chart. Donald J. Wheeler continued Shewhart's legacy by expanding the use of process behavior diagrams (an evolution of Shewhart's control charts) and critiquing methodologies such as Six-Sigma. Wheeler emphasized practical, real-world quality control, aligning himself more with Lean principles than with the statistical approach of Six-Sigma.

If the process and its potential problems are not truly understood, we can start by learning as much as possible about it. We can also train those who are already experts in these basic tools. In the West, we choose to study the process thoroughly in Office Genba before empowering Production Genba experts with the skills to improve their processes. Quality Control Circles (QCC) and Jishu-ken were created to empower process experts to improve. However, in the West, we tend to assign the ability to enhance to a Yellow, Green, Black, or Master Black Belt who isn't truly an expert in the process at the Production Genba.

The consequence is that the process is poorly understood, despite being thoroughly studied in meetings, offices, presentations, and spreadsheets. Data is exhaustively tortured with few practical results. Sometimes, though, as if by magic, another problem and its subsequent causal solution solve the previous issue we've been addressing with vast amounts of statistical analysis. It happens all the time: a process change or readjustment reveals the root problem, and this change magically resolves the problem, and surprisingly, the Six-Sigma project is successful. It doesn't happen all the time, but it occurs more frequently than we think, if we reflect on our historical experience.

Walter Shewhart (1891 – 1967) and Donald Wheeler

The Problem: Process Capacity (Ppk & Cpk)

In the example we'll look at, I won't go into specific details about the process for confidentiality reasons. However, we'll see the steps followed. And we'll see how, as if by magic, the root cause of the problem was found. The situation resolved itself, even after the Six-Sigma project had been abandoned, under the coordination of a Black Belt Master. I must admit that he was a very competent person in his field.

What Would Deming, Juran, Crosby, Shewhart, and Wheeler Think of the American Society for Quality (ASQ) Today?. DAVID DEVOE - Linked-in

There was a process where the long-term Ppk was less than 1. In the short term, the process was sometimes below a Cpk of 0.8. I won't explain here what the PpK (Process Performance Index) and Cpk (Process Capability Index) indicators are. But I'll include the links for your reference. In brief, the capability index measures the relationship between the tolerated variation and the actual variation.

Process capability was measured in the metrology laboratory. Each dimension taken from a sample of manufactured parts was validated in each production

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batch using a highly reliable and accurate system. Most of the dimensions offered very high capacity. The process was “truly capable” at all dimensions (C1..C10), with Cpk around 2. However, there was one dimension (C1) whose variability exceeded the established limits.

The process graph where this variability and possible variables could be evaluated was not being implemented, so this important source of information does not exist.

The first question arises**:** Why these limits? They were established by the client, without scientific criteria. A complex problem to solve. Convincing the client of this excess is a long-term effort. The quality department has statistical quality control tools to achieve this modification: sampling, destructive or non-destructive testing, etc. The quality manager and Master-Black-Belt very efficiently began to reason with the client about whether these limits were essential and appropriate for the product's application and what the necessary sampling limits were.

Second question: Why this variability in only one of the dimensions? The Quality team begins by comparing the line with the problem (L2) and the other line (L1), which does not show this variability. If there is no variability in L1, we can assume that L2 has the problem. L1 was the industrialization test for the product. L1 had smaller post-processing moulds than L2.

Wikipedia: Ppk - Process performance index

The Industrial process

The industrial process includes the following steps. It is a batched chemical process involving water dilution, carried out in two parallel lines: L1 and L2:

a) **Preparation:** Dilution of the mixture (common to L1 and L2)
b) **Forming L1** and **Forming L2**
    a. Shaping the shape by filtering the dilution into the molds.
    b. Pressing 1
    c. Pressing 2 ← **ERROR**
c) **Transport/Conveyance** and preparation for post-processing
    a. Initial process: Transport, manual sorting, and acclimatization (common).
    b. Automated process: Transport and acclimatization (L1 & L2).
d) **Post-processing L1** and **L2**
    a. Step 1..4
    b. On the line validation.

DoE over a wrong assumption.

After a management team crisis meeting, a project manager supported by Mater-Black-Belt is assigned, and a weekly meeting is held to present the results.

The team performs a Design of Experiments (DoE) on the **(d) postprocessing L2**, where the problem is supposedly located. We adjust various parameters, including pressure,

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temperature, and speed, for each step. We even introduce the formed material from L1 and L2 into L2.

After 40 days of testing, a comprehensive table or matrix is created with the DoE results **for (d) Postprocessing L2**. A detailed ANOVA/MANOVA analysis with Minitab© shows no correlation in the variation of the different parameters. A very low influence on the C1 Dimension is detected in only one of the (d) postprocessing processes.

At the end of this chapter, a complete ANOVA analysis is presented, very similar to the one carried out by the team, but using randomized data and an AI prompt to Char GPT Flash.

Unfortunately, the Six-Sigma project was abandoned without determining the root cause of the C1 variation. Production on that line was temporarily halted at the client's request (and other reasons) after approximately 300 hours were spent by project managers, engineers, a Master Black Belt, and operations or production personnel. The total cost: €50K. The Six-Sigma project yielded no results and did not solve the problem.

The failure was also because only two young, inexperienced engineers theoretically affected by the process were invited, along with a project manager with little knowledge of the process. No methodology, timeline, objectives or tasks were assigned. And, without a multidisciplinary team, we jumped to conclusions before assessing the problem from different perspectives. This last point is fundamental, as Kimura Sensei constantly reminds us: diversity is key.

A Chance Discovery

Subsequently, a project was initiated to automate an intermediate step: **Transport/Conveyance (c)**. Thus, 9 months after the completion of the Six-Sigma project, a thermal image revealed that the variability of the **Forming process (b)** on both lines (L1 and L2) was very high and unpredictable over the long term. It was found that **post-processing (d)** helped eliminate this variability, not increase it, as was mistakenly assumed. For this reason, the DoE + ANOVA/MANOVA showed no correlations.

Thus, **the root cause was magically discovered**. The more routine cleaning of forming moulds was established as a standardized preventive measure. Therefore, the problem of high variability in the C1 dimension on L2 was resolved, and consequently, improvements were also made on L1. Of course, other secondary causes could exist, but they were not investigated, and the problem was considered solved, as if "magically."

Does the TEAM understand the process?

Advanced statistical analysis or "data torture" is of no real use if the process is not truly understood. Neither the DoE nor the subsequent ANOVA/MANOVA would have been necessary if the team were experts in the process. The economic effect was significant, not only because of the cost of the Six-Sigma project, but also because it did not serve to study the process in depth. It yielded no positive results, not even in terms of a deep understanding of the process and its potential failures. On the contrary, the team did acquire knowledge of statistical tools and DoE.

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But perhaps the most significant shortcoming was not following the work framework under DMIAC, or PDCA, or 8D, or any other. The team defined (D) the problem poorly. It measured (M) a lot of data in steps that were unrelated to the problem. And that's where it stopped, like many Six-Sigma projects.

In my view, it would have been better to dedicate the hours of this Six-Sigma project to training those who truly understand the process in the ***Production Genba*** and ***Office Genba*** (Quality Control Circles) and invest in the deployment of accurate Total Quality Control (TQC): Standardization + TWI, Visual Management, SQCDEP, QRQC + PDCA, etc. This would create capacity in ***Genba*** or ***Genba-Ryoku***.

And here we connect with Kimura Sensei's knowledge in these recent lectures on TQM (TQM11 and 12): What if the team, instead of performing a deep statistical analysis of a process they were unfamiliar with, had studied the process in depth in several ***Jishu-Ken*** sessions using the KJ method and developing a potential fault tree?

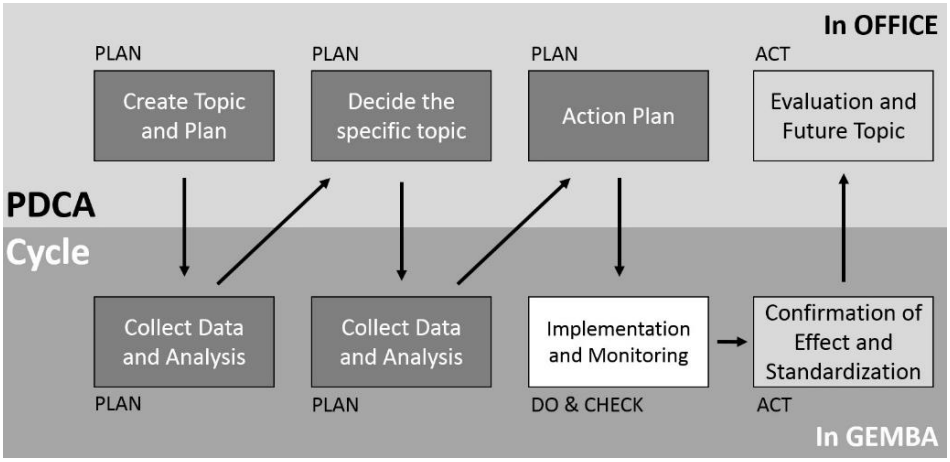
However, to achieve this, project members should, in part, be experts in the process, its risks, and potential failures. Thus, they could have considered all the steps in **Quick Response Quality Control** (QRQC) and simply performed trial and error on their hypotheses to locate the root cause very quickly.

The selection of the team, as we can see, was a significant obstacle. They were capable people, but they didn't know the entire process in depth; they were only grouped into three people: a project manager with a few months of experience in the company and two young engineers specialized in the **Post-Processing (d)**. They were unfamiliar with the rest of the previous processes (a and b). The Metrology Laboratory well supported their work, although no time, responsibilities, objective, or budget was assigned for the project.

Sometimes luck magically solves problems, right? It happens many more times than we think. Sometimes it's due to the talent of the ***Production Genba*** workers, or sometimes it's a coincidence like this one.

But... How should the problem have been addressed, according to the tools Kimura Sensei taught us? Let's see...

The TQC perspective – Scientific thinking and method of the quality control group.



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1- **PLAN (Create the issue and plan)**
   a. We have a problem in C1. We decided to address it with a multidisciplinary team of 5 people. We will use PDCA with a 20-day deadline for resolution.
2- **PLAN (Data Collection and Analysis)**
   a. We now have the historical record of process variation, which is what led us to identify the problem. Therefore, this step is no longer necessary.
   b. We do need to define the work plan (next) and the responsibilities of each team member.
3- **PLAN (Decide on the specific topic)**
   a. **PROBLEM STATEMENT:** We have already defined the problem effect: "high variation in the C1 quota." This identification can be made in the daily or monthly operations, production, or quality meetings. Alternatively, the assignment of work to QRQC (Quick Response Quality Control – While the problem is still burning in your hands) could be done at any of the daily production control meetings. It is not necessary to call another meeting to address the problem. Variability is detected in several batches after several days, and the decision is made at the same daily operations meeting.
   b. **TEAM, TIME, & TASKS (3T**): Create a multidisciplinary team with at least 5 members:
      i. Technicians and Engineers;
      ii. Specialized or specially motivated operators;
      iii. Maintenance Technicians;
      iv. ***Production Genba*** Leaders;
      v. Quality Control Technicians, etc.

      Establish a timeframe for generating results (20 days) and a tentative work schedule based on the following points. ➔ In the same meeting mentioned above, a responsible person is assigned, and the volunteer team and schedule are estimated.
   c. **PROBLEM AND CONSEQUENCES:** Define the problem clearly, not just the effect: "*One or more of the processes generate a variation in one of the parameters with a Cpk of approximately 0.8. This variation exceeds the limits specified by the client, and its stable control is a priority action*."
      We thus establish the priority for allocating resources and time. ➔ This work requires a study session. In this session of the new working group, the problem is defined, and subsequent actions, along with the schedule and responsibilities, are detailed.
   d. **PRODUCTION GENBA**: Likewise, going to where things happen, that is, to the ***Production Genba***, and introducing the workers to the team that will be in charge of resolving the problem is always an excellent idea. This way, everyone knows that this team may need help.
      Reserving a portion of a visual dashboard to detail the group's work and progress is also a great idea. This will enable better communication and facilitate centralized data collection.
4- **PLAN (Data Collection and Analysis)**
   a. **PROCESS STUDY:** Detail the process in one or two self-study sessions. ➔ This work is done in both environments: the Production Genba and the Office. The main reason for this combination is always to confirm what is established in the flowchart.
      i. **MATERIAL AND INFORMATION FLOW MAP:** The method for mapping the process can vary, although I would recommend Toyota's Material and Information Flow Analysis, which is basically a SIPOC

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with a flowchart in the centre and the inputs and outputs of materials, raw materials, documentation, and operator interactions clearly and physically indicated on a large panel or wall, with the main process flow horizontally. The objective is to understand the process in depth, to prepare for the next step. In this case, the VSM is not a good tool.

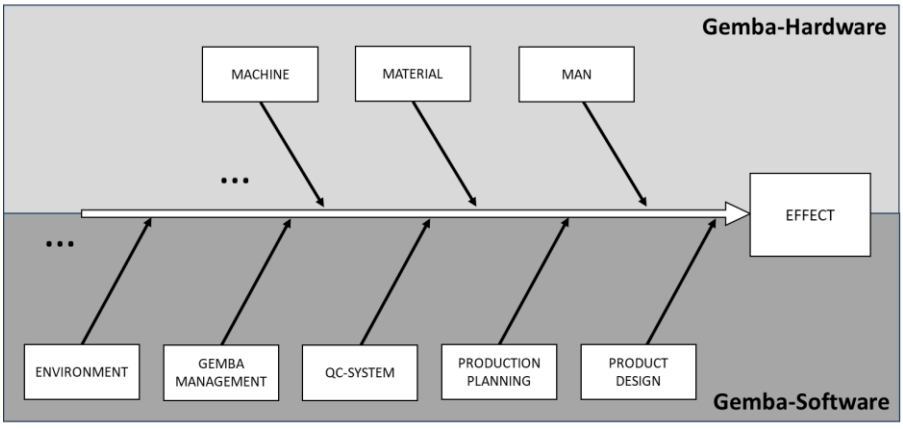
b. STUDY OF POTENTIAL FAILURES: Detail the possible causes of the failure using one or more Ishikawa or KJ diagrams, detailing the possible variations or causes at each step of the process. ➔ Several study sessions and several Ishikawa or KJ diagrams could have been executed. Here is the one that would affect the process, which is done in a very specific way according to Kimura Sensei's scheme and another free scheme considering the processes involved.

i. **KJ METHOD:** The method for developing these diagrams would be the same as that used to create the Potential Problem Map (PPM), which Kimura Sensei described to us in his lectures using the KJ method. The fishbone format is valid, but not the only one. A traditional mind map, as used by Kimura Sensei in his KJ charts, is a good option. And also it is good to represent the potential causes or causes that generate the effect (the effect in the centre of the map).

1. **ESCAPE POINTS and POTENTIAL CAUSES**: Define and detail the possible points in the process where the problem could occur, and which are currently not under control. The escape points will be used to define the failure hypotheses in the next step (See Ford 8D in the attached QR code). Escape points are defined as possible points in the process where a failure could occur. By studying the process using a flowchart, we can identify these “escape points”.

Christoph Roser - When to Use the Eight Disciplines Problem Solving (8D)

Gemba-Hardware & Software as an alternative classification for Cause & Effect Diagram



The following KJ-method diagrams and exercises are not made into a team exercise. It is an “Alone KJ-method”. Can any person make this exercise alone? Unfortunately, not. But it is not only because a deep knowledge of the process is required, but also because a very open mind and creativity are needed. In the following lectures, we will delve into the steps of this exercise.

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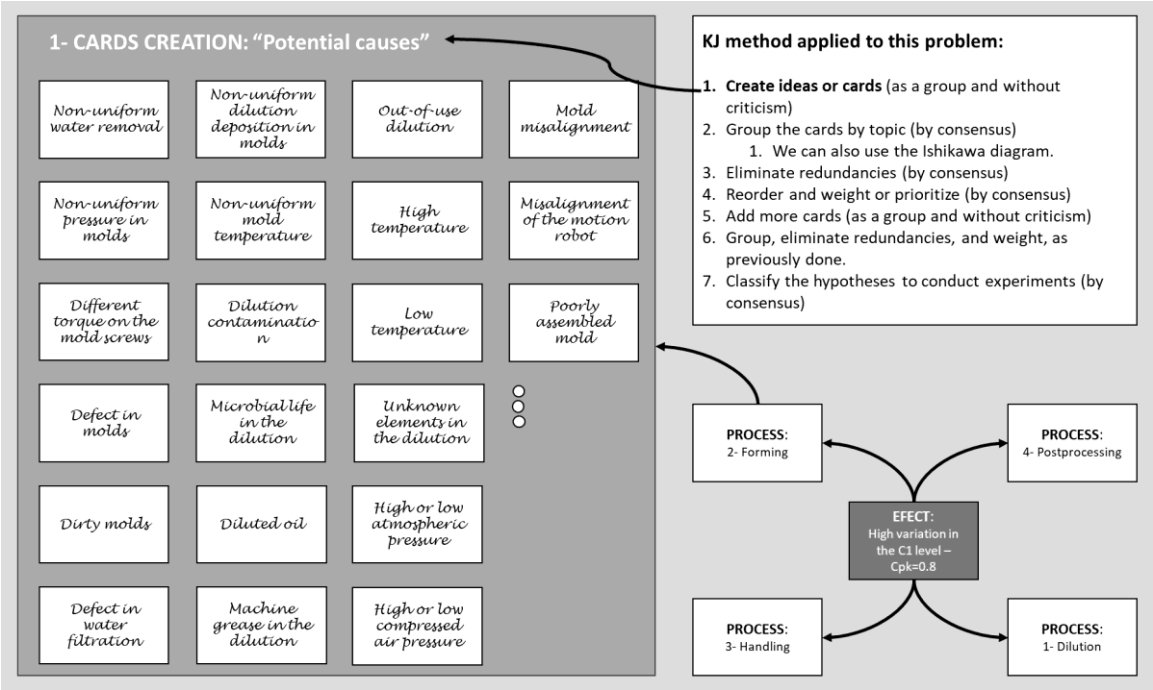
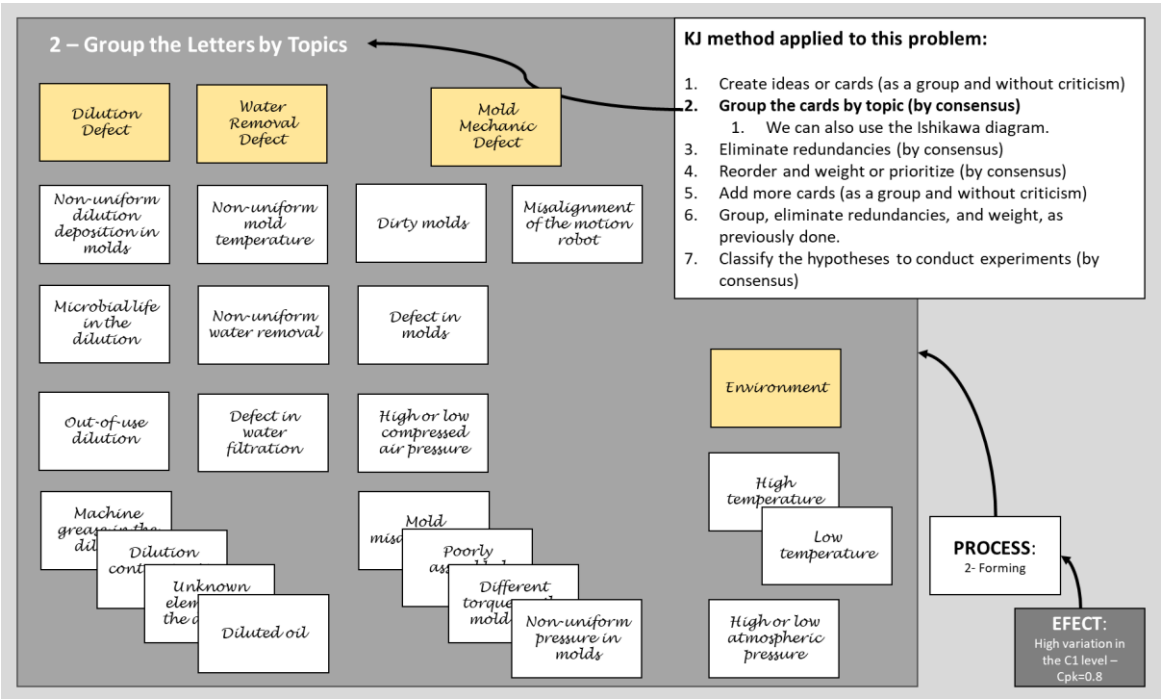

1- CARDS CREATION: "Potential causes"
Non-uniform water removal
Non-uniform dilution deposition in molds
Out-of-use dilution
Mold misalignment
Non-uniform pressure in molds
Non-uniform mold temperature
High temperature
Misalignment of the motion robot
Different torque on the mold screws
Dilution contaminatio n
Low temperature
Poorly assembled mold
Defect in molds
Microbial life in the dilution
Unknown elements in the dilution
Dirty molds
Diluted oil
High or low atmospheric pressure
Defect in water filtration
Machine grease in the dilution
High or low compressed air pressure
KJ method applied to this problem:
1. Create ideas or cards (as a group and without criticism)
2. Group the cards by topic (by consensus)
1. We can also use the Ishikawa diagram.
3. Eliminate redundancies (by consensus)
4. Reorder and weight or prioritize (by consensus)
5. Add more cards (as a group and without criticism)
6. Group, eliminate redundancies, and weight, as previously done.
7. Classify the hypotheses to conduct experiments (by consensus)
PROCESS: 2- Forming
PROCESS: 4- Postprocessing
EFECT: High variation in the C1 level – Cpk=0.8
PROCESS: 3- Handling
PROCESS: 1- Dilution


2 – Group the Letters by Topics
Dilution Defect
Water Removal Defect
Mold Mechanic Defect
Non-uniform dilution deposition in molds
Non-uniform mold temperature
Dirty molds
Misalignment of the motion robot
Microbial life in the dilution
Non-uniform water removal
Defect in molds
Out-of-use dilution
Defect in water filtration
High or low compressed air pressure
Machine
Dilution
Unknown
Diluted oil
Mold
Poorly
Different
Non-uniform pressure in molds
Environment
High temperature
Low temperature
High or low atmospheric pressure
KJ method applied to this problem:
1. Create ideas or cards (as a group and without criticism)
2. Group the cards by topic (by consensus)
1. We can also use the Ishikawa diagram.
3. Eliminate redundancies (by consensus)
4. Reorder and weight or prioritize (by consensus)
5. Add more cards (as a group and without criticism)
6. Group, eliminate redundancies, and weight, as previously done.
7. Classify the hypotheses to conduct experiments (by consensus)
PROCESS: 2- Forming
EFECT: High variation in the C1 level – Cpk=0.8

c. **HYPOTHESES AND EXPERIMENTS:** Establish hypotheses about potential leak points or problems for testing. This is based on the most likely potential problems, agreed upon and weighted by the group in consensus. Start with the hypothesis of the most likely leak point or potential problem.
   i. **EXPERIMENT PLAN:** Detail the plan for executing the first experiment, the necessary equipment, timelines, data collection forms, and expected results. Also, detail the time that will be "stolen" from ***Production Genba*** workers for data collection and training

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needs. A time budget is a valuable exercise for supervisors to assess the necessary human resources and training.

ii. **EXPERIMENT EXECUTION:** Execute the experiment on the production line to validate the hypothesis. Collect data at the scheduled time, checking its progress daily or by shift or hour, to adjust parameters as needed.

iii. **EXPERIMENT EVALUATION**: Evaluate the results of the hypothesis as a group. Adjust the experiment again if necessary. Advanced statistical tools could be helpful, but not doing so is also a good option. Consider simple quality control tools and control charts.

iv. **NEW HYPOTHESIS**: If the experiment based on the hypothesis does not yield the expected results, a second or third experiment can be evaluated among the potential causes previously studied.

v. **ANOVA**: If studying the variables separately does not yield the expected results, we can evaluate correlations. Combining hypotheses and variables is the next step. For this step, it is advisable to use advanced statistical analysis software, such as MINITAB or Artificial Intelligence tools like GPT, Gemini, etc. These tools can perform this ANOVA analysis and the corresponding graphical representations in seconds.

"Now we have identified the root cause."

5- PLAN (Action Plan)

a. **DESIGN THE NEW STANDARDS, CHECKLISTS, AND INDICATORS**: The actions and new standards can be briefly outlined on the A3 sheet.

b. **b. DEFINE THE DELIVERABLES:** A3 sheet, SOI and/or QCPD/DPQC TWI Standards, OPL, etc.

6- 6- **DO (Implement the Solution)**

a. **DOCUMENTATION**: Project closing sessions are just as crucial as the opening sessions. Conclusions can be presented on a sheet of paper to visually and intuitively show the project's impact, even in the ***Production Genba***. The purpose of the sheet of paper is to summarize what we have learned and communicate it quickly and intuitively. It also allows for an exercise in simplification and self-understanding.

…But we're not done yet…

PowerPoint presentations are not welcome because they don't communicate with the ***Production*** or ***Office Genba***.

b. **TRAIN:** New processes and standards must be communicated to the ***Production Genba***. The standard to be implemented must be aligned with the

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TWI-JI[3] perspective to achieve rapid and effective knowledge incorporation. The skills matrix, a long-term training plan, must be updated.

   c. **SIMPLIFY** the team's work on a sheet of paper **DIN-A3** and present it to the ***Kaizen Committee*** (if it exists) for recognition of the effort. Celebrate and acknowledge success!

7- **CHECK (Control the solution)**

   a. The team is responsible for monitoring the progress of the new indicators and standards, as well as their implementation in the Production Genba, and for following up on daily operations in meetings. If we have established new time-based indicators, we can establish their timeframe and officially close the project after that timeframe.

TWI in Wikipedia

What has changed? 3T (Time, Task & Team)

Primarily, **the Team** and its composition have changed. As ***Kimura Sensei*** teaches us, diversity is important, but everyone's participation is absolutely essential. Secondarily, **the process** and agenda have changed.

Tasks have been established based on the PDCA model, utilizing clear output documents (**deliverables**), including DIN-A3, SOI, QCPD, OPL, etc.

In the search for the root cause, the initial DoE led by the Master Black Belt lacks many steps established in the previous PDCA framework.

1. This DoE is established as the start of the project. Causes and correlations are assumed before understanding the process in the real place, product and facts: **3GEN**.
2. The voice of a single person (Master Black Belt) is heard. On the contrary, if we had used the KJ method, the opinions of the entire group would have been heard, without criticism or assessment.
3. There is an overreliance on statistical tools to achieve correlations between factors, assuming erroneous hypotheses. A series of experiments are designed, but neither the process nor the possible causes of the effect (problem) are studied in depth.
4. The project is not closed because there is no conclusion. Thus, the PDCA or DMAIC cycle is not closed because it is falsely closed in the P phase in PDCA or in the M phase in Six-Sigma DMAIC.
5. A QRQC + KJ methodology is now established, which is also well-known in agile projects and project management in general for software development under the motto: "***Low-tech, High-touch***" when in the original case it was exactly the opposite.
6. Finally, one or more exit or closure documents are not established to guide the team's work on the project. Now a PDCA and DIN-A3, TWI Standard: SOI and/or QCPD, OPL are set as a schedule and as deliverables.

[3] TWI-J programs: https://en.wikipedia.org/wiki/Training_Within_Industry https://es.wikipedia.org/wiki/Training_Within_Industry

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Conclusions

It's not that the Six-Sigma project under DMIAC is poorly executed; it's that it doesn't even accomplish anything similar to its DMIAC cycle, nor does it achieve anything comparable to the PDCA cycle, nor 8D, nor the QC-story in a DIN-A3 TQC.

But more than anything, solving problems like the one presented requires taking action in QRQC, or Quick Response Quality Control, while the issue is still burning in your hands.

However, and perhaps without the adequate charter XmR this data table should not being even investigated, just because the Cpk or Ppk only shows a simplified indicator of capacity, not the points actually out of the specification. We should investigate the points out of the specification as soon as possible in QRQC, but not the ranges after some time, when we cannot investigate these points out of the specification just in time. This is a passage of Dr Tony Burns from his website: https://www.qskills3d.com/index.html explains this point:

*You should use this **XmR control charter** when you have either single variable data, or count (discrete value) data, at each point in time. Enter your data point and the time it was taken. Tap a point on the chart to read its value. Out-of-control points are highlighted in red. **The cause for out-of-control points should be investigated immediately**.*

"Professor Deming's protégé Dr Wheeler", the world's leading process statistician, has proved that:

MaxiQ Control Charter by Dr. Tony Burns

- *You should never use p, np, c, u charts, because they depend on the assumption of a data distribution.*
- *You should never normalize data or check for normality. XmR works for any data distribution.*
- *You should never use detection rules other than points outside control limits, to avoid false alarms.*
- *You should never draw distributions over a histogram because you never know the distribution for a dynamic process.*

A control chart (Process Behavior Chart) is an economic chart based on statistics. It is not a probability chart. It does not show a probability of any particular value.

A control chart indicates whether or not a process is predictable. If a process has no points outside control limits, provided it is running within specification, it will continue to give good quality product or service into the future. Points outside control limits indicate the presence of an assignable (special) cause. The special cause may be a shift in the mean or increased variation. This will create an unpredictable process that may result in defects. The process will be incapable of assuring good quality, no matter where specification limits are set. The control chart warns when the process should be investigated.

Every employee has a role in Quality. Q-Skills3D games and interactive exercises teach employees how improve Quality. Q-Skills3D teaches employees how to correctly use and interpret Control charts and histograms.

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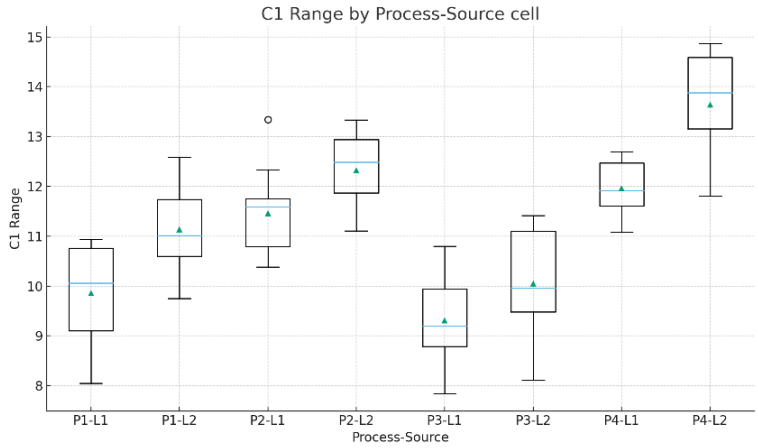
Statistical Analysis using AI

I created a quick prompt for **ChatGPT 5** in September '25. To demonstrate that there is no utility in this deep statistical analysis without diving into the actual process (**3GEN: Genba, Genbutsu, and Genjitsu**). The conclusion of the statistical analysis is useless, as occurred in the real case. It would lead only to more useless work of analysis.

The table provided is randomized, but it is based on real data and analysis. I consciously increase the randomization range by following the parameters: ÷10 for Step 1, ÷15 for Step 2, ÷13 for Step 3, and ÷13 for Step 4. I kept the same random variability for L1 and L2.

I have to say that the DoE analysis was so deeper by ChatGPT. I encourage everyone to take the same test in your console to see how these AI tools can save time and resources in this statistical analysis. However, reading this analysis can be tedious, so you can skip to the end if you are not interested.



DoE example										
			L1 origin range				L2 origin C1 range			
Batch	Units	Dimension	*Step 1 ÷10*	*Step 2 ÷15*	*Step 3 ÷13*	*Step 4 ÷13*	*Step 1 ÷10*	*Step 2 ÷15*	*Step 3 ÷13*	*Step 4 ÷13*
1	32	C1	0.0840	0.0331	0.0012	0.0756	0.0942	0.0064	0.0608	0.0063
2	32	C1	0.0782	0.0176	0.0083	0.0817	0.0955	0.0031	0.0895	0.0085
3	32	C1	0.0707	0.0413	0.0915	0.0639	0.0552	0.0444	0.0262	0.0069
4	32	C1	0.0231	0.0197	0.0480	0.0888	0.0613	0.0438	0.0409	0.0207
5	32	C1	0.0191	0.0502	0.0514	0.0650	0.0218	0.0154	0.0866	0.0678
6	32	C1	0.0572	0.0091	0.0796	0.0343	0.0679	0.0342	0.0439	0.0221
7	32	C1	0.0105	0.0561	0.0847	0.0418	0.0519	0.0258	0.0691	0.0481
8	32	C1	0.0900	0.0502	0.0745	0.0777	0.0467	0.0056	0.0790	0.0769
9	32	C1	0.0719	0.0433	0.0002	0.0701	0.0525	0.0100	0.0986	0.0669
10	32	C1	0.0248	0.0165	0.0590	0.0948	0.0955	0.0505	0.0121	0.0921
11	32	C1	0.0306	0.0515	0.0797	0.0339	0.0679	0.0536	0.0253	0.0426
12	32	C1	0.0103	0.0161	0.0528	0.0773	0.0713	0.0080	0.0184	0.0213
13	32	C1	0.0122	0.0633	0.0359	0.0108	0.0976	0.0052	0.0702	0.0767
14	32	C1	0.0579	0.0015	0.0835	0.0325	0.0475	0.0561	0.0255	0.0875
15	32	C1	0.0300	0.0570	0.0984	0.0814	0.0224	0.0645	0.0594	0.0064
16	32	C1	0.0705	0.0008	0.0588	0.0196	0.0799	0.0340	0.0517	0.0618
17	32	C1	0.0632	0.0636	0.0880	0.0064	0.0573	0.0171	0.0445	0.0837
18	32	C1	0.0348	0.0407	0.0925	0.0746	0.0095	0.0138	0.0840	0.0709
19	32	C1	0.0995	0.0035	0.0901	0.0361	0.0517	0.0618	0.0576	0.0651
20	32	C1	0.0606	0.0433	0.0924	0.0033	0.0846	0.0306	0.0308	0.0845

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The prompt was the following:

> *Perform ANOVA and complex formal statistical analysis, if necessary, to determine the correlation between processes P1, P2, P3, P4, and each source L1 or L2 with respect to the range at dimension C1. Determine whether any of the processes influences the detected variability more than others. Perform this full analysis using all the complex statistical tools you consider, not just ANOVA or complex formal statistical analysis for this table: Show the correlation graphs and statistical graphs you consider to determine this correlation between processes and ranges.*

The answer from ChatGPT 5 was the following:

Full Statistical Workflow

1. ***Reshape the data***
   - *Long format with variables:*
     - *Batch*
     - *Source ∈{L1, L2}*
     - *Process ∈{P1, P2, P3, P4}*
     - *C1_range (numeric response)*
2. ***Exploratory analysis***
   - *Summary statistics (mean, SD per Source × Process)*
   - *Boxplots / violin plots for each factor*
3. ***Two-way ANOVA (factorial design)***
   - *Model: C1_range ~ Source + Process + Source*Process*
   - *Report **F, p-values, η², ω²** for effect size.*
4. ***Assumption checks***
   - *Shapiro–Wilk test for residual normality*
   - *Levene's test for homogeneity of variances*
   - *If violated → run **Welch ANOVA** or **non-parametric (Aligned Rank Transform)**.*
5. ***Post-hoc comparisons***
   - *Tukey HSD for Process differences*
   - *Pairwise t-tests (adjusted p-values) for Source comparisons*
6. ***Correlation & regression***
   - *Regression model with Process (dummy-coded) and Source*
   - *Point-biserial correlation for Source vs. range*
   - *Interaction plots*
7. ***Visualization***
   - *Boxplots (by Process, Source)*
   - *Interaction plot (Process × Source)*
   - *Residual diagnostics (histogram, Q–Q plot)*

✅ *This will give us a rigorous answer to:*

- *Does **Source (L1 vs L2)** significantly affect C1 range?*
- *Do **Processes (P1–P4)** differ in variability impact?*
- *Is there a **Source × Process interaction** (i.e., some processes behave differently depending on L1 or L2)?*
- *Which process contributes **most** to the variability?*

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Would you like me to:

👉 (A) Run the full analysis directly on this table now (you'll get ANOVA tables, effect sizes, plots, correlations, etc.),

or 👉 (B) Export the reshaped dataset first so you can review it before I proceed?

My answer was: "Run the full analysis directly (A)"

Done — I ran the full analysis on your DoE table and saved the results and plots. Below I give a concise, actionable summary of the statistics, the most important numeric results, interpretation, and next recommended steps.

Key numeric results (concise)

- *Design used: 20 batches × 4 processes (P1..P4) × 2 sources (L1,L2) → 160 observations total.*
- ***Two-way ANOVA (Process, Source, Process×Source)** (Type II)*
  - ***Process**: F = 9.28, **$p = 1.1 \cdot 10^{-5}$** — statistically significant.*
    - *Effect size: **$\eta^2 \approx 0.153$**, **$\omega^2 \approx 0.136$** (Process explains ~13–15% of total variance — medium effect).*
  - ***Source (L1 vs L2)**: F = 1.35, p = 0.248 — not significant.*
  - ***Interaction (Process × Source)**: F = 0.126, p = 0.945 — not significant.*
- ***Levene's test (homogeneity of variances across the 8 cells)**:*
  - *statistic = **3.005**, **p = 0.0055** → **variances are not equal** (heteroscedasticity).*
- ***Shapiro–Wilk normality by cell (per Process×Source)**:*
  - *Some cells show evidence of non-normality (notably L2/P1 and L2/P2 had p < 0.05). Several other cells look OK.*
- ***Point-biserial correlation (Source L1=0 / L2=1 vs C1 range)**:*
  - *r = **−0.086**, p = **0.279** → small, non-significant correlation.*
- ***Process correlations with C1_range (exploratory, one-hot)**:*
  - *P1: r ≈ 0.114*
  - ***P2: r ≈ −0.391** (the largest magnitude)*
  - *P3: r ≈ 0.129*
  - *P4: r ≈ 0.148*
- ***Regression (OLS) c1_range ~ process + source** (reference = P1, L1):*
  - *Intercept ≈ 0.0562 (P1 baseline mean)*
  - *C(process)[T.P2] ≈ −0.0255, p < 0.001 → **P2 has significantly lower mean C1_range than P1***
  - *C(process)[T.P3] and C(process)[T.P4] not significantly different from P1*
  - *C(source)[T.L2] ≈ −0.0050, p = 0.244 → source not significant in regression either*

Files produced (all in /mnt/data):

- *anova_table_c1.csv — ANOVA table with η^2 and ω^2*
- *group_stats_process_source.csv — counts, means, std, min, max per Process × Source*
- *tukey_process.csv — Tukey HSD pairwise comparisons (Process)*

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- *shapiro_by_cell.csv — Shapiro–Wilk per Process×Source cell*
- *analysis_summary.txt — textual summary and regression output*
- *Plots (displayed inline): cell boxplots, interaction plot, residual histogram, QQ-plot, mean ±95% CI per process.*

Interpretation (short)

1. ***Process is the dominant explanatory factor*** *for variability in the C1 range (significant ANOVA, medium effect size). In particular* ***Process P2*** *shows a substantial negative effect on the response (lower C1_range).*
2. ***Source (L1 vs L2) does not significantly affect C1_range*** *in this dataset ($p \approx 0.25$). The interaction between Process and Source is negligible — processes behave similarly across L1/L2 on average.*
3. ***Assumption checks*** *reveal issues:*
    - ***Heteroscedasticity*** *(Levene $p = 0.0055$) — group variances are unequal.*
    - ***Some group-level non-normality*** *(Shapiro $p < 0.05$ in a few cells). Because of these, the ANOVA p-values should be interpreted with caution — Type I error could be affected by unequal variances. However, the process effect is strong ($p \ll 0.01$) and an effect this size is unlikely to vanish under robust tests.*

Robustness / alternative checks I recommend (and can run if you want)

Because Levene's test shows unequal variances and some cell normality is borderline, we should confirm the process effect using one or more robust approaches:

1. ***Welch's ANOVA*** *(handles unequal variances) — for each factor or for process main effect.*
2. ***Brown–Forsythe test*** *(a Levene variant more robust to non-normality).*
3. ***Permutation ANOVA*** *(non-parametric, distribution-free p-values).*
4. ***Robust regression*** *(Huber or biweight) to estimate process effects without sensitivity to heteroscedasticity/outliers.*
5. ***Transformations*** *(e.g., log) only if it makes process meaningfully homoscedastic and interpretation remains sensible.*

If you want, I can run Welch ANOVA and permutation ANOVA now and report whether the process effect holds (my expectation: ***Process will remain significant****, especially the P2 difference, because the effect size is moderate).*

Practical conclusion & recommendation

- ***Operationally****, Process choice matters for C1_range.* ***P2 stands out*** *as producing systematically lower C1_range values (and is the largest contributor to the observed differences between process means).*
- ***L1 vs L2*** *does not appear to be a key driver of variability in this metric in your DoE.*
- *Because variance is unequal across cells, before finalizing decisions I recommend we run the robust checks listed above. If they confirm the same conclusion (likely), then you can target* ***P2*** *for further investigation (why it*

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yields lower range — is it desirable or not?), or consider shifting process parameters to reduce variability where required.

Would you like me to:

- *(1) **Run Welch ANOVA and a permutation ANOVA** now to confirm robustness? (recommended), or*
- *(2) **Produce a short formatted report (PDF/PowerPoint)** with the plots and the main tables for sharing, or*
- *(3) **Drill down**: pairwise comparisons among processes broken down by source, or examine batch-level trends/outliers?*

Tell me which and I'll run it immediately and attach the results.

Tornuring the data

Well, this analysis can delve deeper into the statistical Analysis, as you can see in the answer above. So ChatGPT is a potent tool in this regard; however, it is not the target of this presentation to show the ability of the AI tools to make complex statistical analysis, but only to show the potential and the dangers of this kind of "statistical masturbation" that can fill lots of pages in presentations, and hours of useless resources. Imagine translating this answer into a PowerPoint presentation and spending two hours on a team to present these results that offer no conclusions.

Is that correct? …I don't know, I think so. What I do know is that it was, and is, useless. And that's simply because even with random data, ANOVA analysis can reveal relevant correlations on these data based on real data. In the real world, we were searching for the root cause in the wrong dataset and at the wrong time, as you can read earlier. The statistical analysis means nothing without proper planning and creative work, as emphasized in the P phase of the PDCA. Often, such statistical analysis is unnecessary, as Dr. Deming has stressed repeatedly.

In this example, the question may be whether the same AI tool can help generate new ideas in the KJ-method deployment to identify new and unexpected potential problems or ways to solve them, or represent the ideas gathered. In the following lecture, we will explore one possible outcome of such an experiment and discuss one way to leverage these AI tools for a more in-depth analysis.

Eduardo L. Garcia

Factory Management Institute - CC4

September 2025

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